THE ENGINEER.

British Machine Tools at the Olympia Exhibition.

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THE first Machine Tool Exhibition organised by the Machine Tool Trades Association was held in October, 1912. During the war the machine tool industry of this country, like every other section of the engineering trade, was far too busy to think of exhibitions, even although it had been possible and desirable to organise one, and it was not until September, 1920, that another was held. Four years later the Association had to decide whether it should allow its members to exhibit their products at the British Empire Exhibition at Wembley, or to restrain them from doing so, and to arrange its own exhibition as usual. For reasons which many held to be sound, the decision was taken not to support the Empire Exhibition, and in September, 1924, the third Machine Tool Exhibition was held at Olympia. It cannot be denied that the Association's policy of withholding its support from Wembley resulted in the engineering section of that Exhibition being deficient in its representation of the British industry. At the same time, it cannot be denied that the Olympia Exhibition of 1924 was from the point of view both of the Association and of those who exhibited at it, and visited it, a very distinct success.

Four more years have passed, and now the fourth Exhibition organised by the Association is open at Olympia. It began on Wednesday of this week, September 5th, and will remain open until Saturday, September 22nd. So far as our studies of the exhibits permit us at this date to form an opinion, we believe we can promise the engineering visitor, whether he is bent on the immediate purchase of machine tools or on instructing himself in the latest developments in their design, that he will find plenty to interest him. He may perhaps notice here and there some machines which he saw at the previous Exhibition or with which he is otherwise already familiar. He will, however, no doubt reflect that an Exhibition such as that which he is visiting is intended to be a display of products which the exhibitors desire to sell, and not primarily a gallery of novelties. Some interesting new designs are included in the Show, but, generally speaking, the progress which the Exhibition registers is the cumulative effect of many minor improvements applied to machines, the main lines of which have become more or less standardised.

In this Supplement we give descriptions of some of the machines shown by British makers. Our selection of the exhibits to be described in it has been governed largely by the ability of the individual exhibitors to give us facilities for obtaining information in advance concerning the machines they are showing. In some cases we have, for the time being, had to pass by important exhibits, because of the lateness of the date at which they have been completed. With these and other machines and exhibits we propose to deal in the pages of our ordinary issues during the currency of the Exhibition.

JOHN STIRK AND SONS, LTD.

As our readers are no doubt already fully aware, John Stirk and Sons, Ltd., of Halifax, have for some considerable number of years specialised in the design and construction of electrically driven machine tools, and, in particular, of electrically driven planing machines and boring and turning mills. In our issue of February 18th, 1927, we described in considerable detail the design, construction, and operation of a large example of the Stirk "Hiloplane" planing machine, and to that account we may refer those of our readers who desire to study the general features of the Stirk system as applied to planing machines. On the firm's stand at Olympia will be found a small "Hiloplane" machine admitting work measuring 60in. wide by 60in. in length, and embodying most of the distinctive features of the large machine described in our previous article. Like the large machine, the small example exhibited is of the double standard type, and is provided with four tool-boxes, two on the cross slide and one on each of the standards. The electrical driving system is such that the various feed motions can be, in general, converted into cutting motions, and *vice versâ*. As a consequence, it is possible to plane on the machine the top, sides and ends of a rectangular block without re-setting it on the table. In addition, it is possible to plane certain of the surfaces in either of two directions. For example, the top surface may be planed longitudinally in the usual way or crosswise, while the sides can be planed either longitudinally or vertically.

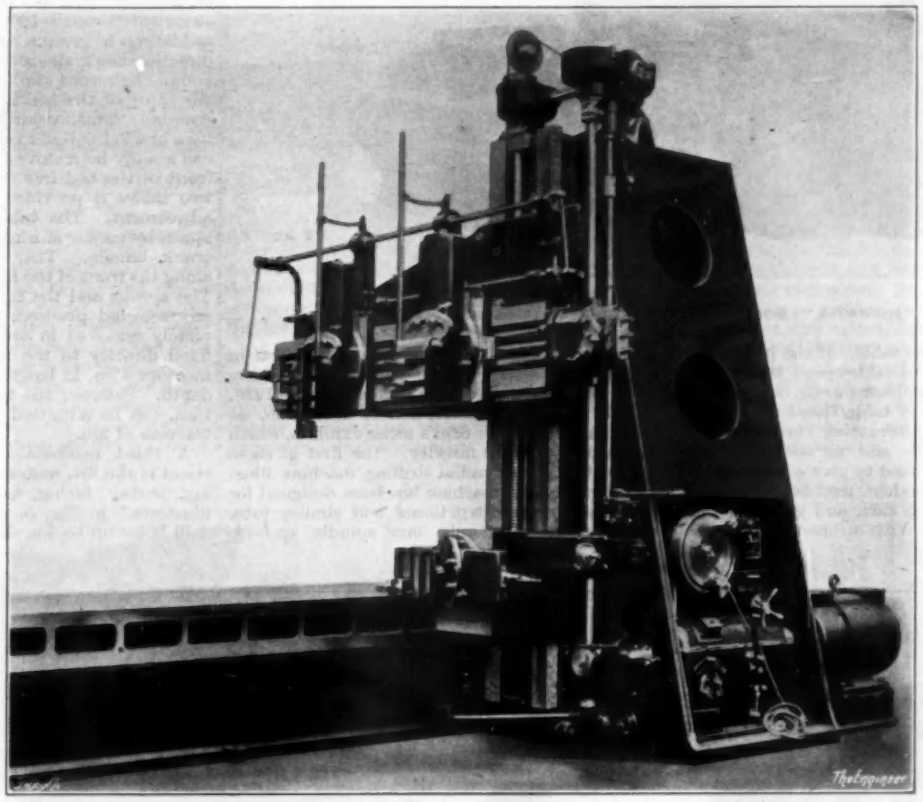


FIG. 1—OPEN-SIDED "HILOPLANE" PLANING MACHINE—STIRK

A similar machine embodying the general features of the "Hiloplane" system is the open-sided planing machine which Messrs. Stirk are also exhibiting and which we illustrate in Fig. 1. This machine can accommodate work measuring up to 6ft. in width and 16ft. in length. The table is described by the makers as being of an improved box bridge design. The column attached to one side of the bed is recessed at the foot for the receipt of the feed-box and the disc whereby the length of stroke of the table is adjusted. On the vertical guides of the column there are provided a side cutting head and a horizontal overhung cross slide carrying two cutting heads. The electrical driving system is of the Stirk patented split field reversing type. This system is a modification of the well-known Ward-Leonard drive. It makes use of a primary motor taking either direct or alternating current from the mains and driving a generator, the manipulation of the magnetic field of which enables current at variable voltage and of alternative polarity to be produced. The variation of the generator voltage varies the speed of the main driving motor operating the table, while the change of polarity reverses the direction of rotation. In the generator, the shunt field windings are divided into two sections, which are connected to oppose each other, and as a result the alternative excitations of the sections gives the desired alternative polarity. In the main driving motor the shunt field windings are also divided into two sections, but these two sections are connected in agreement, and one is lighter than the other. The light section is permanently excited, but the heavy section is excited only during the cutting stroke. The increase in the field strength when both sections are excited gives the slow speed required on the cutting stroke and during the other portion of the cycle the decrease gives the high speed for the return stroke. A supplementary reversing motor supplies the power for the feeds, power traverses, the elevation of the cross slide, and the power required to take the cut in cross and vertical planing. The electrical equipment also includes a starter for the primary motor of the motor generator set, a control panel containing two contactors and two shunt regulators, governing the reversal of the table and the ratio of the cutting and return speeds, a change-over switch, whereby the variable voltage current can be applied either to the main motor driving the table or to the supplementary motor when that motor is used for cross or vertical planing, and an accelerating switch whereby the speed of the table may be temporarily increased at any point of the cutting stroke.

Between the main driving motor and the pinion meshing with the table rack there is a two-speed mechanical change gear, which gives the high and the low ranges of speed hinted at in the name of the machine. The stroke of the table is controlled by the disc shown on the side of the column. This disc is geared to the table, so as to make one complete turn for a full stroke of the table. Two adjustable dogs on the disc operate in conjunction with a master switch, which in turn operates the contactors in the control panel, and thereby determines the polarity of the current supplied to the main driving motor. If the distance between the dogs is varied, the length of the stroke is changed, and if the two dogs are moved without altering the distance between them, the position of the stroke is varied. The feed is applied almost instantaneously at the end of the cutting stroke of the table by the supplementary motor shown on the extreme right in our engraving. This motor can be set to make exactly one-half or a whole turn at the end of the cutting stroke. Its motion is transmitted through a three-speed change gear-box, so that six different feeds are obtainable. In addition, two extra broad feeds for finishing cuts can be obtained by an additional change gear. The various alterations in the duty of the machine required for changing from one style of planing to another by interchanging the feeds and the cutting motions are obtained in the manner described in detail in our issue of February 18th, 1927. A similar remark applies to the quick

and slow power traverses to the cutting heads, the elevation of the cross slide by power and the relief of the tools on the return stroke by a magnetic tool lifting device.

Another machine on Messrs. Stirk's stand is the 72in. "Hilomill" boring and turning mill illustrated in Fig. 2. The base of this machine is cast in one piece and carries the two uprights which are tied together by a deep rail. The cross slide can be rigidly fixed at any desired height on the uprights. The two heads on the cross slide are arranged to swivel and are fitted with spring balanced rams. An oil-immersed

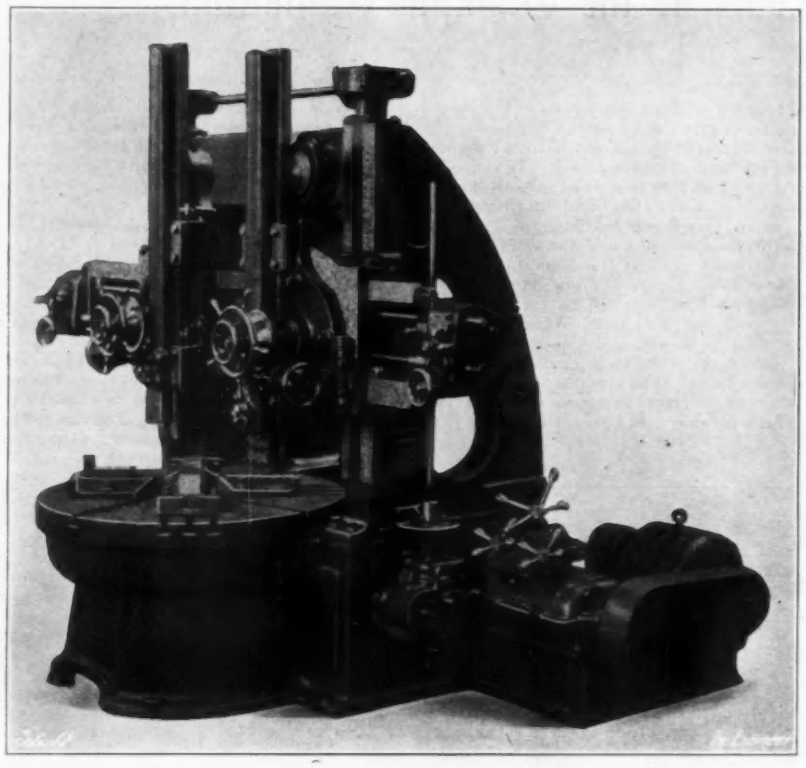


FIG. 2—"HILOMILL" BORING AND TURNING MILL—STIRK

anti-friction bearing supports the table. If the power available is direct current, a variable-speed motor, in conjunction with three main change gears, is used to give a continuous variation of table speed over a wide range. If the supply is alternating current, a constant speed induction motor and an additional six-speed change gear-box are fitted to give a total of eighteen table speeds. Independent feed-boxes are fitted to the heads, one on each side, and give nine rates of feed in all directions. With a direct-current supply a patented starter regulator is provided, which allows for an unlimited amount of inching when the work is being set, and subsequently ensures starting under a full field with an automatic return to a predetermined speed. Quick power traverses are given to the heads in all directions by a supplementary motor controlled from a pendant switch.

A fourth machine exhibited by Messrs. Stirk is a "Veloplane" planing machine taking in work measuring 36in. by 30in. by 72in. An interesting feature of this machine is its self-contained overhead countershaft mounted on the cross rail which ties the tops of the uprights together. A gear-box embodied in the countershaft enables the machine pulleys to be driven by two belts, both of which are "open." This gear-box also gives three cutting speeds, and a constant return speed, namely, 24ft., 36ft., and 48ft. per minute and 100ft. per minute.

GEORGE SWIFT AND SONS, LTD.

Among the several machines on the stand of George Swift and Sons, Ltd., Claremont Ironworks, Halifax, is a motor-driven gap bed lathe almost identical in design with the machine by the same firm which we described in our issue of September 10th, 1926. Rather than repeat our description of that lathe, we will deal with three of the firm's other exhibits, which contain features of some novelty. The first of these tools is the 6ft. girder radial drilling machine illustrated in Fig. 3. This machine has been designed for repetition work on constructional and similar jobs, and is provided with only one spindle speed—300 r.p.m.—and one rate of feed—95 cuts per inch. The spindle is driven and fed by a 5½ horse-power motor running at 1450 r.p.m. placed vertically on top of the saddle. A pinion on the motor and a large driving wheel on the spindle are the only two gear wheels used in the main drive. The feed is derived from a smaller wheel on the spindle lying below the large driving wheel, and is transmitted to a rack on the spindle sleeve through spur and worm gearing. The power feed is applied by means of a friction coupling, and when that coupling is disengaged the spindle can be raised or lowered quickly by hand. The spindle has a hand or self-acting vertical traverse of 15in. It is a high-carbon steel forging and revolves in a long steel bush fitted with a ball bearing at the bottom end and a ball thrust washer at the upper end. The saddle travels along the arm on roller bearings, and is moved by means of a star handle and a rack and pinion. A lever to the right of the saddle is provided for the purpose of locking the saddle to the arm and the arm to the column. The arm when this lever is unlocked swings freely on the pillar, on which it is supported by means of ball and roller bearings. A starter for the motor is mounted on the right-hand side of the saddle. The spindle can be fixed on the arm at any distance from 1ft. 4in. to 6ft. from the centre line of the pillar. A height of 4ft. 3in. can be admitted between the floor and the spindle.

The second machine exhibited by Messrs. Swift which we have selected for description is the 16in. single traversing head shaping machine illustrated in Fig. 4. This machine has a bed 6ft. long, and on it the headstock can be traversed through a distance of 4ft. 5in. The drive to the head is taken from a four-speed belt cone, with which a fly-wheel is associated, on to a back shaft, whence power is taken to the ram through double reduction spur gearing. The final drive to the head is made by way of a slotted link connected to the centre of the ram and giving a powerful central thrust drive with a quick return motion. The ram is provided with square side gibs and on a circular face at its front end carries the tool slide. The nominal length of stroke of the ram is 14in., but it can be varied up to a maximum of 16in. Vertical, radial and angular movements are provided at the tool slide, all three movements being effected by means of screws. Power feed can be applied to the vertical and angular movements. To facilitate easy setting on angular work, the tool-box is indexed and can be swivelled through 180 deg. The headstock or ram saddle can be given a hand or self-acting feed in either direction along the bed, the feed being applied at the end of the return stroke of the ram. Projecting from the front of the bed is a self-acting circular motion mandrel. This mandrel is supported at its outer end by a bracket bolted to one of the tables. The mandrel can readily be removed when it is desired to have the front of the bed free from projections. Each of the two tables is provided with vertical and horizontal adjustment. The table is moved vertically on its apron by means of a rack and a pinion operated by a crank handle. The apron is moved horizontally along the front of the bed by another rack and pinion. The aprons and the tables can be securely bolted in any selected position, and, if desired can be completely removed in order to allow large work to be fixed directly to the front of the bed. The tables measure 17in. in length, 15in. in width, and 12in. in depth. Between the tables and the tool a height of 15in. can be admitted. The tool-box has a vertical traverse of 8in.

A third machine exhibited on Messrs. Swift's stand is the 6ft. motor-driven high-speed radial drilling, boring, facing, tapping and studding machine illustrated in Fig. 5. This machine is designed to drill holes up to 3in. diameter and to tap threads up to 2¼in. Whitworth or 4¼in. gas. It is driven by a 12½ H.P. shunt wound, protected, direct-current motor running at 900 r.p.m., supplied by Electromotors, Ltd. The motor is mounted on a bracket extension of the arm, and is geared to the main driving shaft. Beneath its bracket there is suspended a Brookhirst starting panel, comprising a stop-and-start switch, a moving coil ammeter, and an automatic solenoid control panel. The drive is transmitted from the motor through a gear-box giving

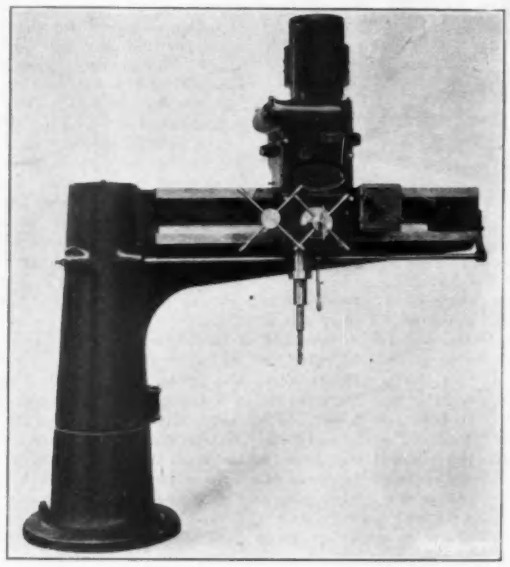


FIG. 3—RADIAL DRILLING MACHINE—SWIFT

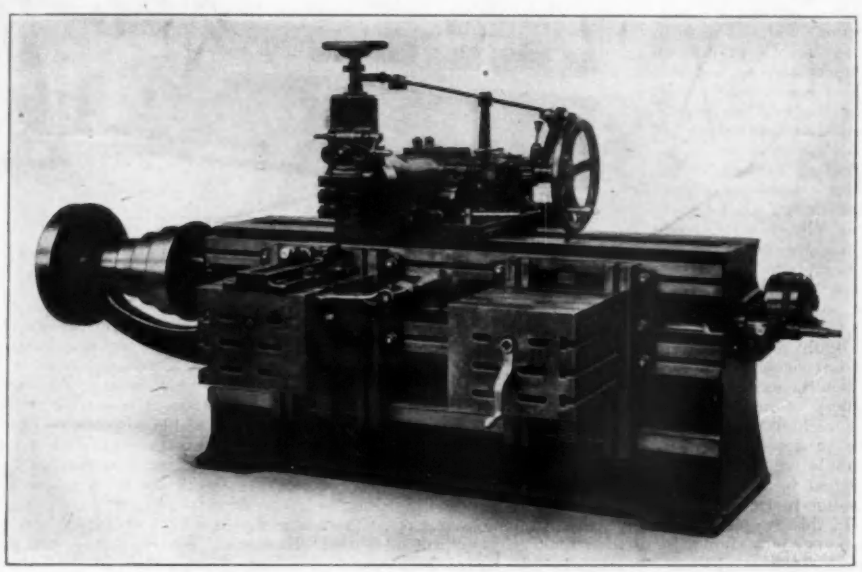


FIG. 4—TRAVERSING HEAD SHAPING MACHINE—SWIFT

nine changes by means of two handles. This gearbox is carried on the arm, and, in addition to it, there is a single and double gear change provided on the saddle. The eighteen spindle speeds thus obtained range from 27 to 500 r.p.m. The double gear ratio is four times the single gear ratio, so that by changing from double to single gearing at the saddle the operator can back out taps at four times the tapping speed. Four rates of feed ranging from 30 to 120 cuts per inch are obtained by the movement of a single lever on the saddle. An automatic trip motion fitted with an indexed dial and a safety stop is provided to prevent the over traversing of the spindle by the automatic feed. The spindle is balanced by means of a compensating spring and can be easily moved up and down through the agency of a star-handle. A second star handle is provided for traversing the saddle along the arm. This motion is made by means of a steel rack and pinion, and is facilitated by the fact that the saddle is supported from the arm on roller bearings. A single lever on the saddle enables the operator to lock the saddle to the arm and simultaneously the column carrying the arm to the vertical pillar within it. The column revolves on roller and ball bearings supported by the pillar. A lever at the foot of the column operates a power elevating motion for the arm. An automatic knock-off device is provided to trip this power motion when the arm comes near the top or the foot of the column, and a safety device is fitted which makes it impossible to put the elevating motion into gear if the arm is clamped to the column by the lock provided for that purpose.

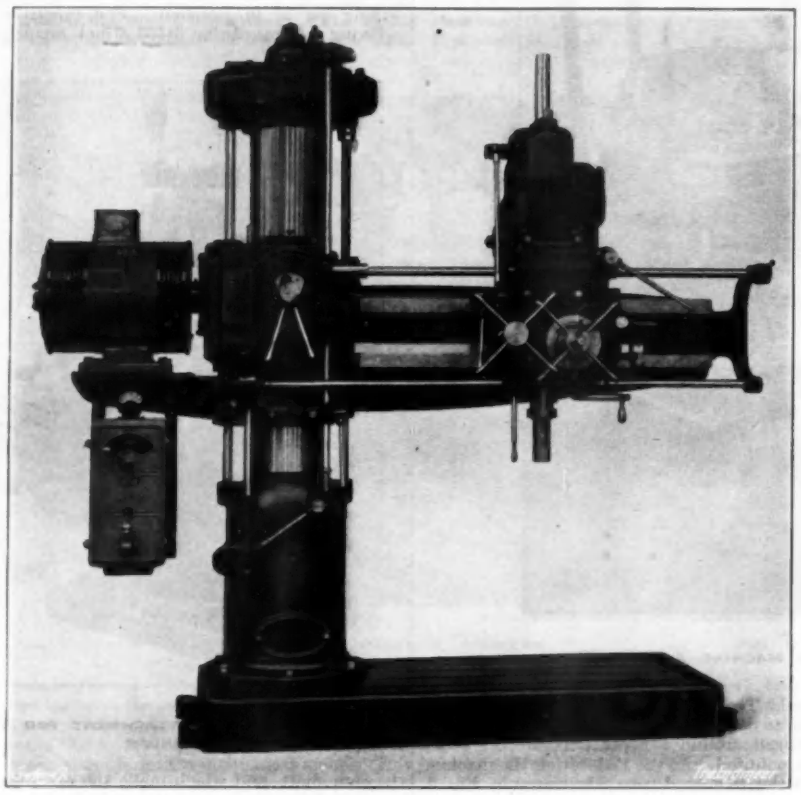
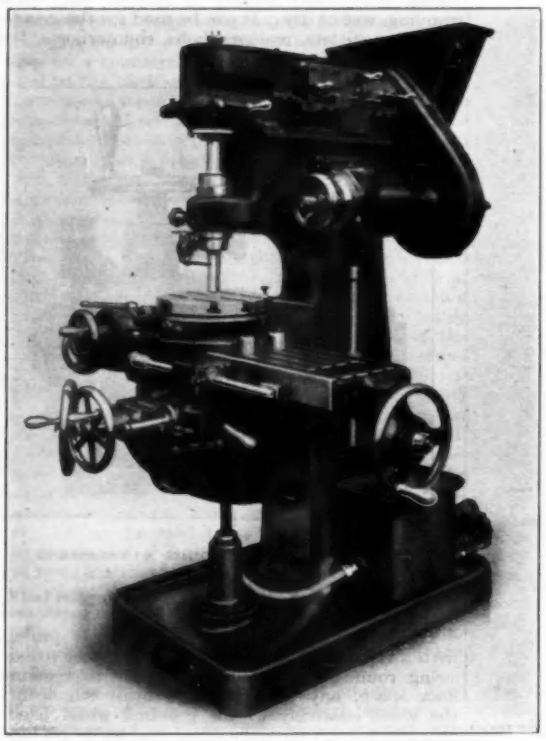


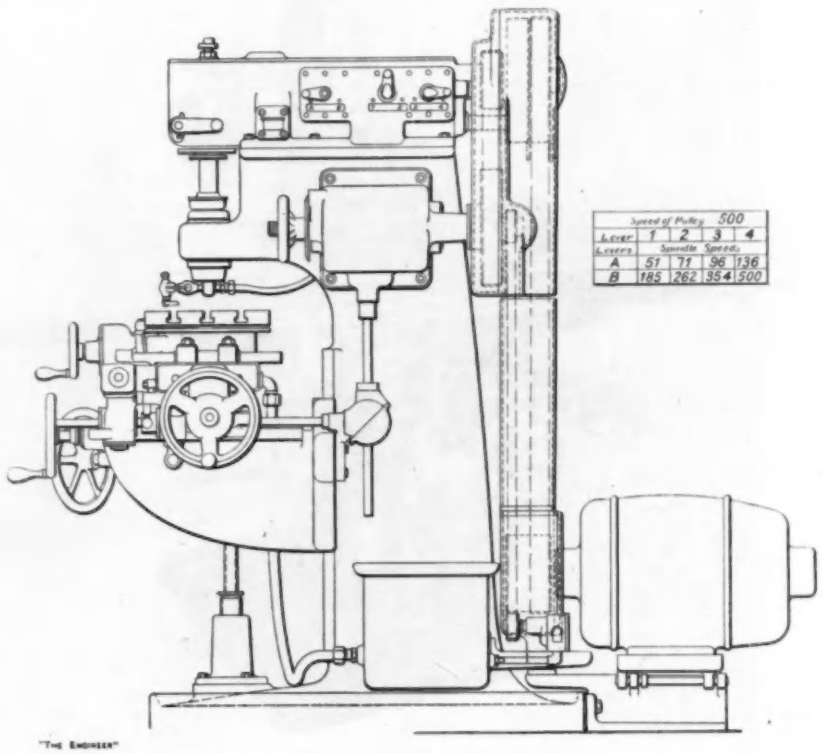
FIG. 5—HIGH SPEED RADIAL DRILLING, ETC., MACHINE—SWIFT

ALFRED HERBERT, LTD.

The machine tools and other equipment exhibited by Alfred Herbert, Ltd., of Coventry, require for their display no fewer than seven stands. We can make no pretence to deal adequately with them. Fortunately we can plead that many, if not most of the machines, shown by the firm have already been described in our columns. Some of the most important of the exhibits fall into this category. For example, the very powerful No. 28 V vertical milling machine was fully described in our issue of May 4th, 1928, the No. 4 capstan lathe in our issue of November 18th, 1927, the No. 19 hexagon turret lathe with covered beds very completely in our issue of June 18th, 1926, and the No. 16 V high-power universal milling machine in our issue of September 19th, 1924, in connection with the previous Machine Tool Exhibition. The three machines which we have selected for description on this occasion have been chosen, therefore, not because they are in any way to be regarded as the three most important exhibits shown by Messrs. Herbert, but because they are new, wholly or in part, and because we have not previously dealt with them.

The No. 15 V vertical milling machine illustrated in Fig. 6 represents a re-designed version of a successful earlier type. The improvements introduced in the course of the re-designing have been adopted with a view to increasing the robustness of the machine, its ease of operation, and its speed of working. The machine, as indicated in Fig. 6A, can readily be arranged for an electric drive by means of a 4 horse-power motor mounted on a hinged support carried by an extension which is bolted to the column base. It will be noted that in both forms of drive the belts, following Messrs. Herbert's modern practice, are very fully guarded. The main driving belt is moved from the fast to the loose pulley or *vice versâ* by means of a crank handle at the front of the machine. Eight changes of spindle speed, ranging from 51 to 500 revolutions per minute, are obtained from change gearing situated inside a driving box which is mounted on top of the column and which at one end carries the bearing for the driving pulley shaft and at the other the upper bearing for the cutter spindle. The change gearing is of the sliding type with four-splined shafts and runs in oil. The gear shafts and the loose pulley are mounted on ball bearings. From the final gear shaft to the spindle the transmission is made by means of spiral bevel gearing. The upper bearing of the spindle is a roller bearing and the lower is lined with white metal and is adjustable. The spindle head is fixed, vertical adjustment being obtained by raising or lowering the knee on which the saddle and table are mounted. The knee is moved up or down by means of a hand wheel and telescopic screw provided with a ball thrust. It can be clamped in position and can be moved up against an adjustable dead stop. The saddle sliding on the knee is moved by hand power and is provided with a clamp and adjustable dead stops. The table sliding longitudinally on the saddle can be moved by hand or by an automatic feed. Power for this longitudinal feed is obtained by belt from the fast and loose pulley shaft. Nine different feeds, ranging from $\frac{3}{4}$in. to 10$\frac{1}{2}$in. per minute, are given by change gearing contained in a box bolted to the side of the column and controlled by the maker's patented dial feed motion. The feeds can be reversed by means of a knurled handle in front of the hand wheel of the dial motion. The table has a working surface of 49in. by 10$\frac{3}{4}$in. On top of it a circular table 13in. in diameter may be bolted. The edge of this table is graduated. Provision is made for applying an automatic feed to it by an extension of the feed system operating normally the longitudinal motion of the table.





FIGS. 6 AND 6A—VERTICAL MILLING MACHINE—ALFRED HERBERT

For a number of years past Messrs. Herbert have been studying the construction of multi-spindle drill heads, whereby an ordinary single-spindle drilling or

boring machine can be converted into a high production multiple-spindle machine. Various types of these heads are now being produced by the firm. In one form the drills, to the number required by the user, are arranged at fixed centres to suit the user's requirements. In another form the head carries up to twenty drills arranged with their centres on a straight line. The pitch of the drills can be arranged to be varied either independently or by means of an auto-spacing device, whereby all the pitches are increased or decreased uniformly. In a third form the head carries from two to twelve drills arranged on a circle, the diameter of which, and consequently the circular pitch of the drills, can be varied by means of a concentric adjustment. In other forms of head the drills are provided with a universal adjustment. In one such head as many as fourteen drills may be mounted and each spindle may independently be driven at any one of three speeds to suit the size of drill which it is carrying.

The development of this line of multi-spindle drill heads has been followed by the development of a line of multi-spindle drilling machines, to which the heads may be fitted. These machines consist of a horizontal bed carrying two, three, four or even six multi-spindle heads, arranged around a central fixture on which the work is mounted. At the Exhibition the machine shown is of the two-head type illustrated in Fig. 7. This engraving shows the machine at work, drilling magneto bodies. As set up for this work it is equipped with twenty-seven drills of various diameters and performs the drilling operations in cycles of 25 seconds. The saddles carrying the multi-spindle drilling heads are fed to the work and returned by means of cams, although, as an alternative, a hydraulic feed can be fitted. The heads can be set to work simultaneously or in sequence, and to trip automatically at the end of each cycle or to operate continuously. Each spindle has three independent speeds, so that holes of different diameters may be drilled or reamed at the most suitable speed. In addition, the machine can be arranged to tap the work after the drilling is completed. A safety device is incorporated in the design, which prevents the heads being fed to the work until the drilling jig is in position. For repetition work, indexing fixtures can be fitted, which are driven from the cam shaft, and which make the operation of the machine fully automatic, the attendant being called upon only to remove the finished work and to insert a fresh piece while another is being drilled. In the case of work drilled without the use of a cutting fluid, a suction equipment can be fitted for the removal of the swarf.

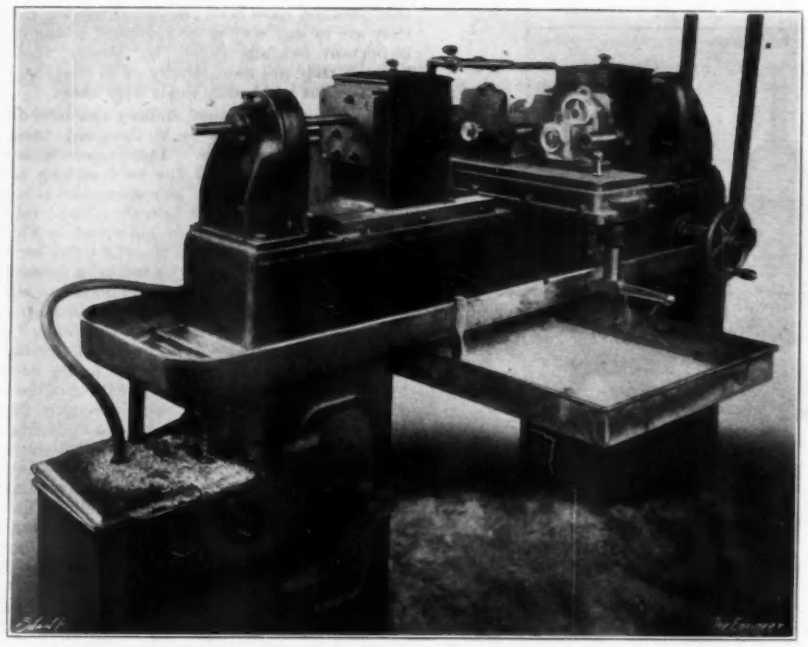


FIG. 7—TWIN-HEAD MULTI-SPINDLE DRILLING MACHINE—A. HERBERT

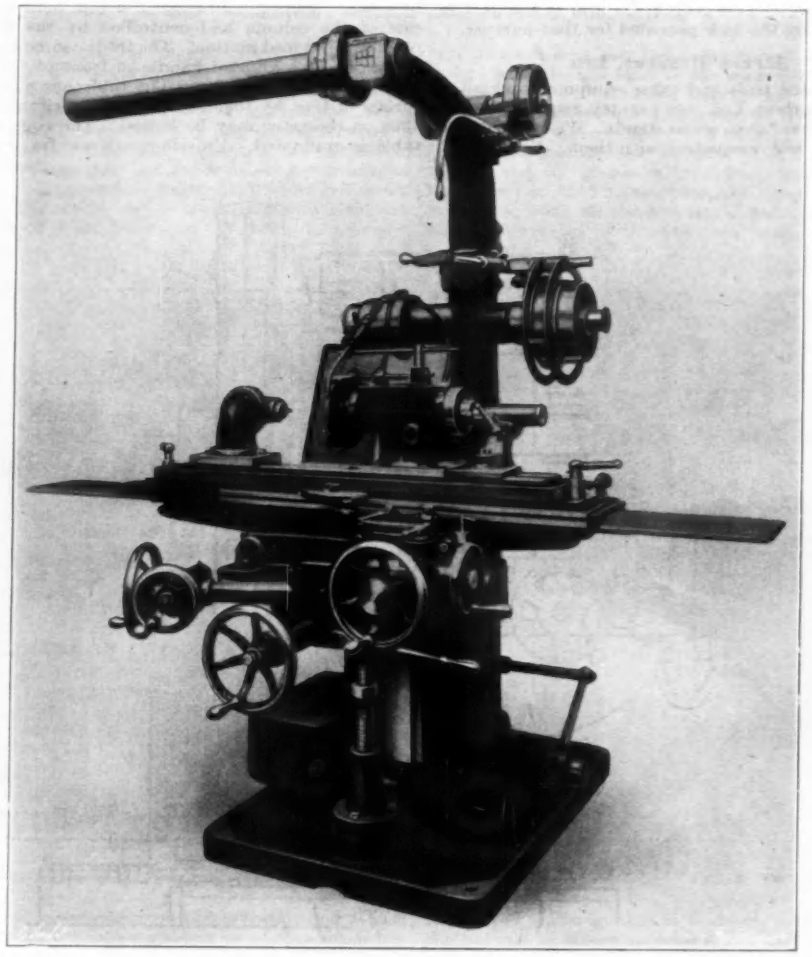


FIG. 8—UNIVERSAL CUTTER AND TOOL GRINDER—A. HERBERT

Another new machine shown by Messrs. Herbert is the universal cutter and tool grinder illustrated in Fig. 8. This machine is entirely self-contained. It requires no separate countershafts, even for circular grinding with automatic longitudinal traverse. If required, it can be arranged to be driven by a single motor mounted on the body casting. The machine is intended for general tool-room use, and when fitted with the necessary extra parts is capable of undertaking almost any variety of circular and surface grinding, wet or dry. It can be used for the grinding of milling cutters, reamers, hobs, counterbores, form tools, saws, gauges, &c., and can be adapted both to external and internal circular grinding.

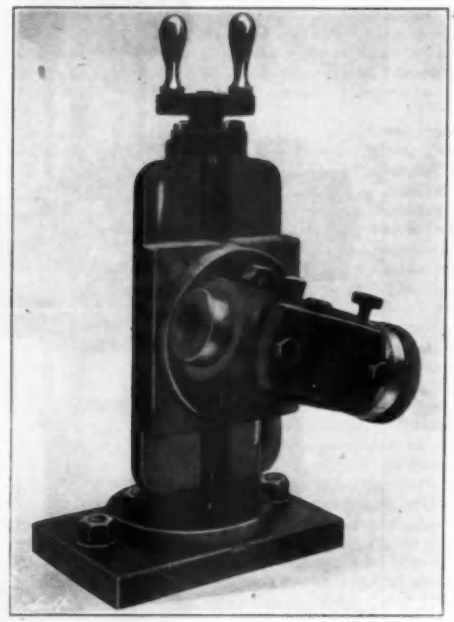


FIG. 9—UNIVERSAL ATTACHMENT FOR TOOL GRINDER

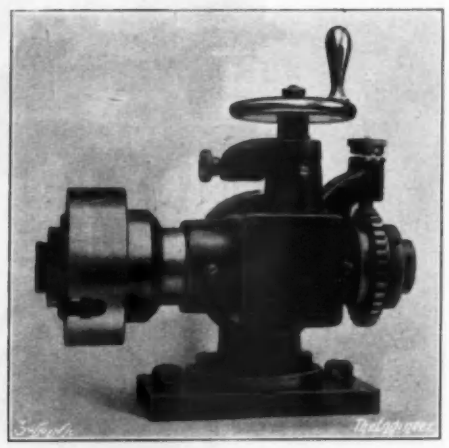


FIG. 10—INDEX GRINDING ATTACHMENT

The knee supporting the work table is provided with a rising and falling motion, but is not fitted to swing round the column. In order to economise floor space, any required adjustment angularly of the work relatively to the grinding wheel head is obtained by swivelling the wheel head on its graduated base. The knee is raised and lowered by means of a telescopic screw and hand wheel. It is fitted with a graduated index disc and a lever clamp. The saddle sliding transversely on top of the knee is moved by means of a rack and spiral pinion and two hand wheels. One of these hand wheels imparts a quick movement to the saddle, and is employed for traversing the work quickly past the wheel, the cut being put on by a slow longitudinal movement of the work

table. The other handle gives a slow transverse movement, and is employed to put on the cut when the work is being traversed by a quick longitudinal movement of the table. The work table is in two parts. The lower is supported on longitudinal slides on the saddle. The upper part swivels on the lower, and can be set to any desired angle against a graduated scale. A separate small angle scale is provided, and is fitted with a fine screw adjustment. The upper table may be removed, so as to set free the lower table for long grinding work. The longitudinal movement of the lower table on the saddle is imparted by means of a rack and pinion, and two hand wheels, giving, as in the case of the transverse movement of the saddle on the knee, a quick and a slow movement. This feature of providing a quick and a slow movement to the table in both directions is patented, and is claimed to give a universal character to the machine, enabling it to grind a greater variety of work without special appliances than any other machine can handle. The vertical adjustment of the table covers a range of 15in., the transverse movement a range of 7½in., and the longitudinal movement a range of 32in.

An automatic longitudinal table traversing attachment, giving three speeds and a reverse motion, can be fitted in place of the quick and slow longitudinal hand traverse. This automatic longitudinal traverse, it is stated, is very useful for surface grinding, and is almost essential, if much circular grinding has to be done.

The graduated swivel base on which the grinding wheel head is mounted is carried on the top of the machine column. The wheel spindle is driven through spiral gearing by a belt taken to a three-stepped pulley on a countershaft carried on a pillar which is bolted to the back of the column. With a motor of 3 horse-power running at 950 r.p.m. the three spindle speeds obtained are 3222, 4492 and 6190 r.p.m. The countershaft carries a fast and a loose pulley, and an automatic brake is fitted to the fast pulley. As shown in Fig. 8, the machine is fitted for circular grinding. The work in this arrangement is rotated by belt taken over a long overhead drum supported by an arm which forms an extension of the pillar carrying the main countershaft. The drum is driven by a three-stepped pulley from a countershaft at the rear of the arm, which countershaft, in turn, is driven from the main countershaft. By means of a fast and loose pulley on the subsidiary countershaft, the rotation of the work can be stopped without stopping the machine as a whole.

The work table is furnished with a tailstock having a spring adjustment to accommodate the expansion of slender cylindrical work, when it is being ground, and with a swivelling work head. This work head, as may be gathered from Fig. 11, is mounted to swing about a horizontal axis and to swivel about a vertical axis, both movements being made against a graduated scale. It can be used to carry various fittings for different classes of work, such as a plain centre, a spindle with a standard taper hole, arbors of various kinds, special bushes and collets, a pulley and centre for external circular grinding, or, as shown in Fig. 11, a pulley and chuck for internal circular grinding. The three speeds which may be given to the work are 200, 280 and 400 r.p.m.

Space does not permit us to deal at all adequately with the numerous accessories with which the machine may be supplied or with the manner of their use. In Fig. 12 we illustrate the machine arranged for the grinding of a large inserted tooth milling cutter. The cutter arbor is carried in a universal attachment, bolted to the table. This attachment consists of a vertical piece rotable on a graduated base and carrying a screw-operated slide fitted with a graduated turntable swivelling about a horizontal axis. On the turntable there is mounted a holder having an adjustable swivelling jaw, whereby parallel or taper shanks may be held. The holder may be removed from the turntable, and in its place there may be substituted—as shown in Fig. 9—the carrier removed from the swivelling work head. Fig. 12 also shows the use of a tooth rest fitted in a universal holder, which is bolted to the table. The blade of this tooth rest can be adjusted to the correct distance below the grinding wheel centre, to give the required clearance, by means of a micrometer attachment. The tooth rest can also be mounted on the grinding wheel head, on the swivelling work head, or on the universal attachment. The internal circular grinding attachment shown in Fig. 11 is driven by belt from the main grinding wheel spindle. It can be driven at any one of three speeds, namely, 11,140, 15,530, and 21,400 r.p.m., and is suitable for use with a diamond lap. Another fitting is the index grinding attachment, illustrated in Fig. 10. This fitting is used for work that requires accurate spacing with an index plate, such as the teeth of clutches, flats on arbors, &c. The chuck employed is one and the same with that shown in Fig. 11. It is carried on a spindle rotated by a hand wheel and fitted with an index plate. The chuck and its spindle can be swivelled horizontally and vertically against graduated bases.

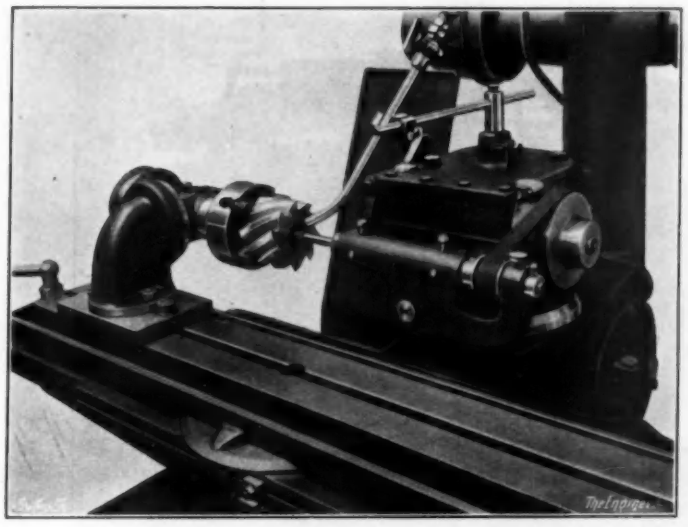


FIG. 11—INTERNAL GRINDING ATTACHMENT—A. HERBERT

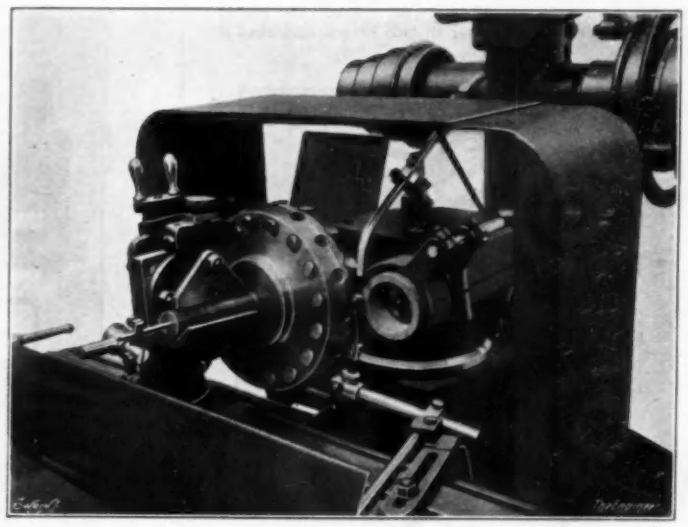


FIG. 12—GRINDING INSERTED TOOTH MILLING CUTTER—A. HERBERT

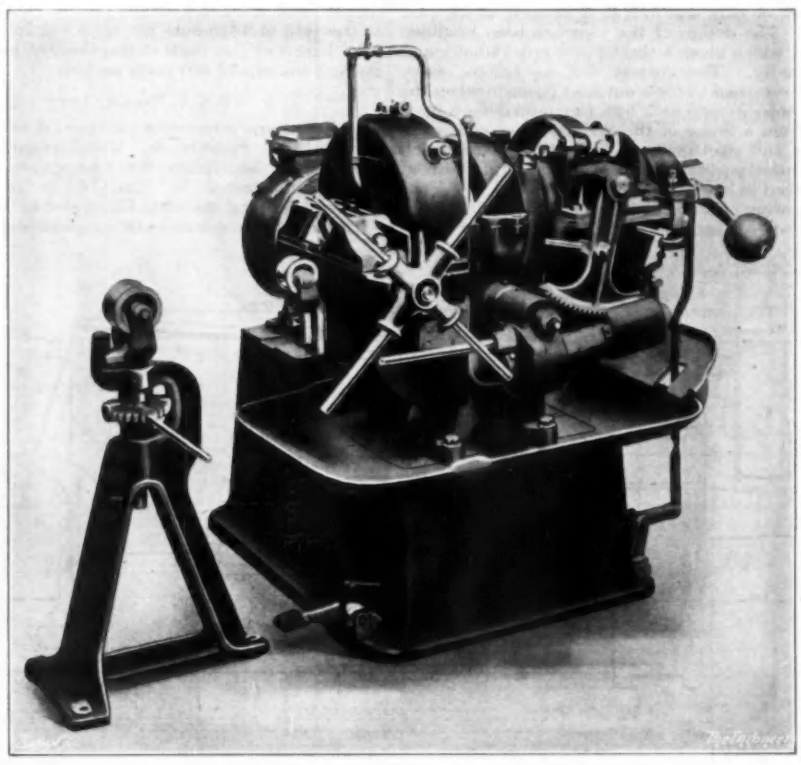


FIG. 13—ROTARY CUTTING-OFF MACHINE—TAYLOR

CHARLES TAYLOR (BIRMINGHAM), LTD.

Cutting-off and sawing-off machines are the principal exhibits on the stand of Charles Taylor, Ltd., of Birmingham.

The rotary cutting-off machine illustrated in Fig. 13 embodies the characteristic features which we have described on several occasions in the past—notably in our issue of January 22nd, 1915—when dealing with Messrs. Taylor's cutting-off machines. The example illustrated can deal with bars or tubes from ½in. up to 3in. in diameter, or, by the removal of certain parts, up to 4in. The stock is held steady in a vice operated by a large star handle, while a pair of cutters revolve round it. This system of working eliminates the necessity for revolving long and heavy stock, and at the same time facilitates the moving up and re-gripping of the stock, for during these operations the rotation of the cutters need not be stopped. The cutters are carried on two slides moving on a head at the end of a hollow cast iron spindle, the bore of which is fitted with a retaining ring of a size to suit the diameter of the stock being cut. The feed to the cutters is applied by chains passing through the spindle, the arrangement being such that the cutters are automatically balanced and compelled at all times to share the work equally between them. A slight offset of one cutter relatively to the other is given in order that the cut of the one may provide the necessary clearance for the other. No clearance is given in the usual way on the cutters themselves, and as a consequence they require to be ground on one face only. The cast iron spindle is driven by a hardened steel worm and phosphor bronze wheel running in oil, the driving power being supplied by an electric motor of about 4 horse-power, mounted on an extension of the base. From the worm shaft power is also taken to supply an automatic feed movement to the cutters. The feed transmission embodies a cast iron segment meshing with a worm. An adjustable stop, consisting of a short rod projecting from one side of the segment arm trips the feed at the end of the cut; that is to say, when it reaches the centre in the case of

a solid bar or before it reaches the centre in the case of a tube. An emergency hand trip for the feed is also provided. The feed is engaged by pressing downwards on the horizontal handle to be seen behind the star handle of the vice. When the inward feed is tripped the cutters return automatically to their outmost position under the action of springs. An adjustable stop is provided to limit the maximum opening of the cutters to an amount just sufficient to accommodate the stock being cut. The spindle can be driven at either of two speeds, namely, 130 and 260 r.p.m. As an indication of the capabilities of the machine we may say that it can cut off 110 pieces from a 3in. round steel bar in two hours, and that it

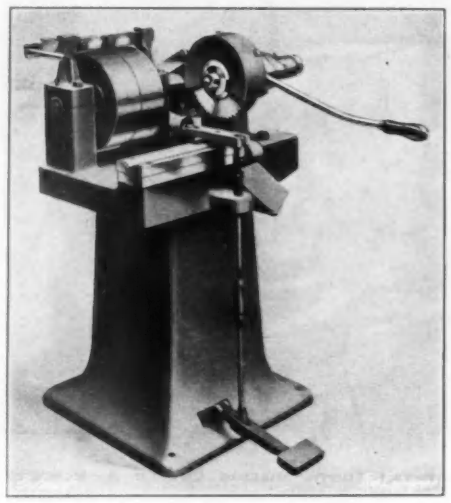


FIG. 14—SAWING-OFF MACHINE—TAYLOR

can cut off a 2in. gas tube at the rate of one piece in eighteen seconds.

In a larger size of cutting-off machine on Messrs. Taylor's stand, one capable of dealing with bars from 2in. to 4½in. in diameter, or with tubes between 3in. and 6½in. in outside diameter, the same general principles with a few additional features of interest are to be noted. In this machine the cutter slides are operated by means of power-driven feed screws instead of by chains. One rate of feed only is provided, namely, 0·036in. per revolution of the spindle in the case of bars and half that amount in the case of tubes. The design of the vice has been modified to a form which gives a three-point grip radially and longitudinally. The cutters are, as before, automatically returned to their outmost position when the cut has been completed, but the return motion is derived from a brake of the Weston type, consisting of bronze and steel plates. When the cutters reach their outmost position the brake slips until the feed is re-engaged to cut off the next piece.

The sawing-off machine illustrated in Fig. 14 is designed to saw off definite lengths of non-ferrous extruded metal rods, sections, and tubes, as required in the production of hinges, the parts of locks and switches, and so forth. The saw, 8in. diameter by $\frac{1}{16}$in. thick, is driven from the belt pulley spindle by steel spur gears totally enclosed in an oil-tight case. The frame carrying the saw is balanced by means of a spring at the back of the machine. The saw is fed down through the work, with the aid of the hand lever attached to the frame, and when there is no pressure on this lever the balancing spring acting on the frame lifts the saw clear of the work. A detachable steel guard protects the saw, and is easily removed when the saw has to be replaced. A universal stop adjustable to accommodate varying sections and lengths is provided to ensure the accurate sawing off of the lengths of the section being operated upon. The steel guide plate shown in our engraving is 9½in. long, and is suitable for round rods from ¼in. to 1¾in. in diameter. Special guide plates to suit any form of extruded section can readily be substituted for the standard guides. During the sawing-off process the stock is held firmly against the guide plates by means of a universally adjustable gripping device operated by a foot lever. A shoot catches the parts as they are sawn off, and conducts them into a receptacle. A round brass rod, ¾in. diameter, or a simple form of small extruded section can be sawn off at the rate of 1440 cuts per hour. A hinge section, 4½in. long and ¾in. thick at the thickest point, can be sawn at the rate of 500 parts an hour.

B.S.A. TOOLS, LTD.

Of the several interesting machines shown by B.S.A. Tools, Ltd., Sparkbrook, Birmingham, we have selected for description the four-spindle automatic machine illustrated in Figs. 15 to 18, and the universal lapping machine illustrated in Figs. 19-20.

The four-spindle automatic machine was originally developed for the production of parts from bars fed through the hollow spindles. The machine exhibited represents a modification of the original design in so far as it is of the chucking type, and is intended for automatically producing components from forgings, steel blanks or castings, which cannot be fed through the machine like a bar but have to be inserted one at a time. The chucks are of the mechanically-operated, scroll, or expanding collet type according to the nature of the parts to be machined. The four spindles, each of which carries a part to be machined, are driven at a selected cutting speed which is common to them all. They are mounted in a rotatable carrier which at intervals is automatically indexed through 90 deg. Opposite the spindle carrier and situated coaxially therewith is a main tool slide—see the diagram, Fig. 18—the end of which is square in section with T-slots at the corners. By means of these slots tool boxes or holders can be clamped to the main slide. The tools inserted in these boxes or holders are drills, reamers, recessing tools, boring bars, or other kind of end-cutting tool. When set in position on the main slide the tools are coaxial with the chuck spindles in one or other of the four stations. In addition to the main slide there are a front and a rear slide moving crosswise on which forming or facing tools may be fixed. The feed movements of the three slides are synchronised with the indexing movements of the work spindle carrier. In the case of a drilling or other end cutting operation, the drill or other tool is held stationary on the main slide and consequently the cutting speed is that determined by the rotary speed of the work spindle. This speed may have to be fixed to suit the requirements of, say, a forming tool in one of the cross slides, and may consequently be less than can be used with advantage on the drilling operation. To meet this possibility a live spindle can be fitted opposite two stations of the work spindles. These spindles are driven in a direction opposed to the rotation of the work, and, as a consequence, the cutting speed of the tools fixed in them is the sum of the work spindle and the live spindle speeds. The live spindles are placed coaxially with the work spindles. Room for their insertion is provided by the fact that the main slide is situated centrally and has its corners cut off. A tapping or

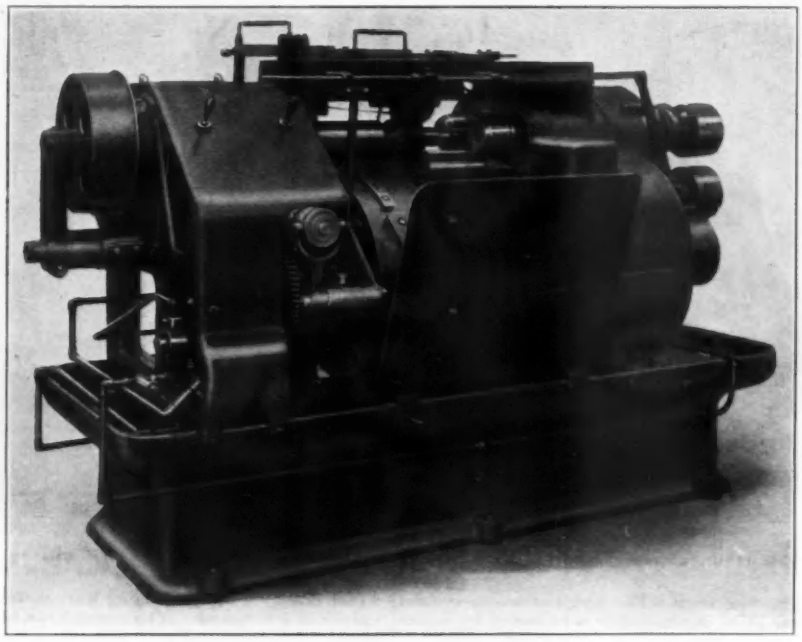


FIG. 16—FOUR-SPINDLE AUTOMATIC MACHINE—B.S.A. TOOLS

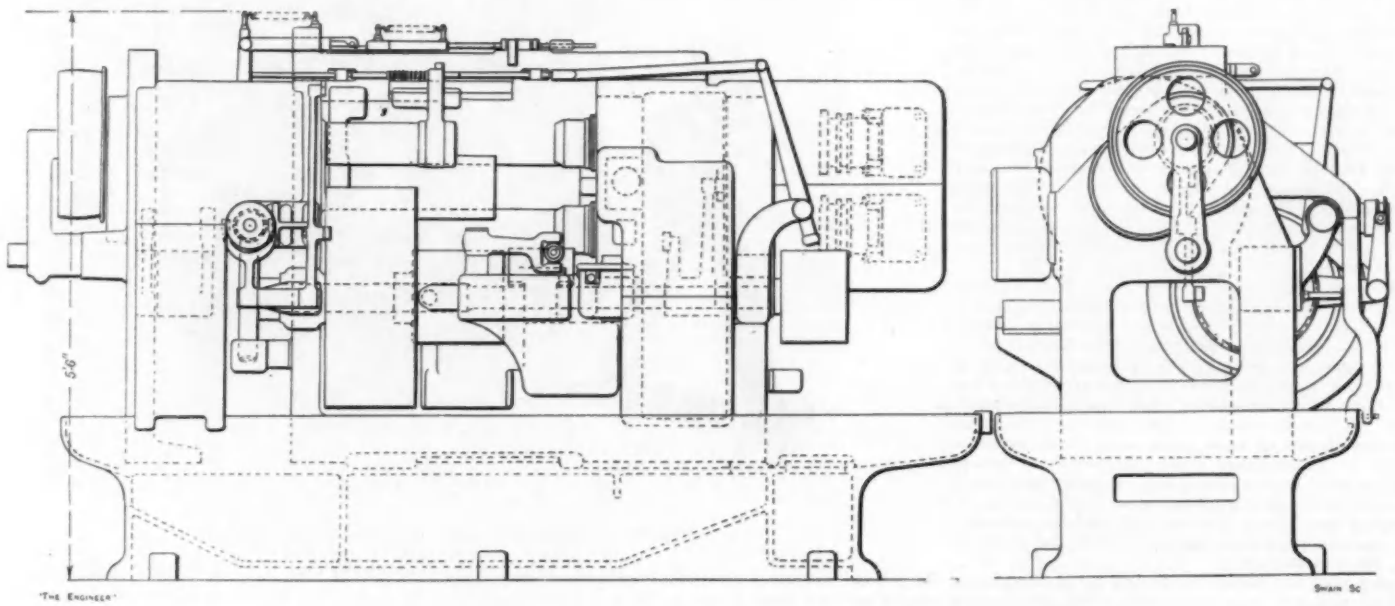


FIG. 15—FOUR-SPINDLE CHUCKING TYPE AUTOMATIC MACHINE—B.S.A. TOOLS

threading spindle can be substituted for one of the live spindles. For a right-hand thread the tapping spindle is driven in the same direction as the work spindle but at less speed. The cutting speed is then the difference of the two. After the required length has been threaded the tapping spindle speed is automatically increased until it is in excess of the work spindle speed and, as a consequence, the tap withdraws from the work. For left-hand thread cutting the tool is revolved at a greater speed than the work during the cutting process and at a reduced speed for withdrawing. The top front station of the work

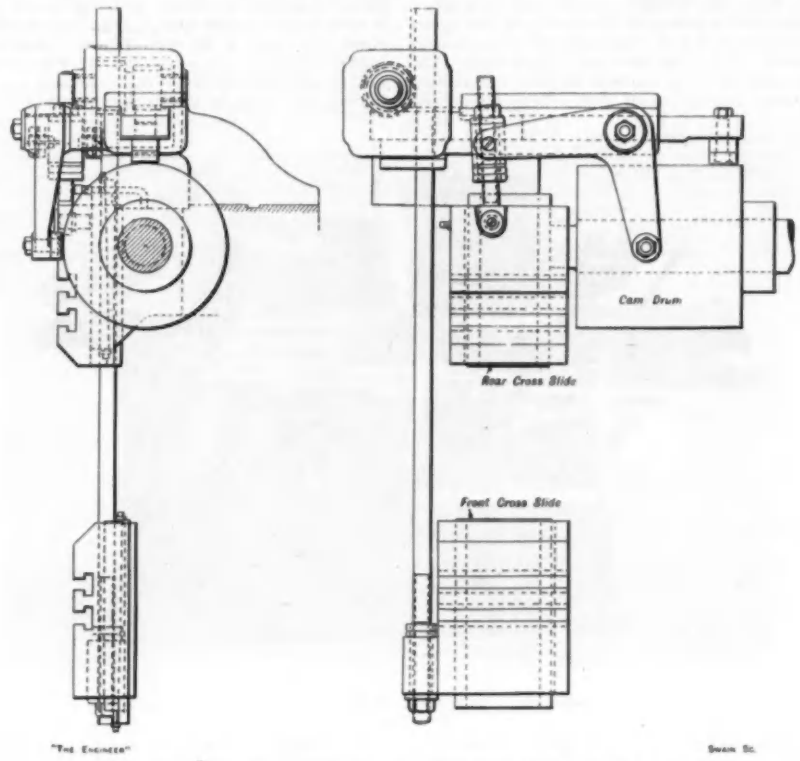


FIG. 17—CROSS SLIDE FEED DETAILS—B.S.A. TOOLS

of the tools can be stopped while it is in progress. In general it is possible to arrange that some machining shall be done on the components at all four stations, and that at each quarter turn of the work spindle carrier a finished component shall be removed from the machine.

In the space at our disposal it is only possible to give a brief description of the constructional details of the machine. The housing mounted on the base provides at the right-hand end—Fig. 15—a support for the spindle carrier, and at the left-hand end a support for the spindle carrier shaft and for the main

the centre of the main tool slide to a bearing at the driving end of the machine. From the main driving pulley at the left-hand end the drive is diverted in two directions. The first branch is taken through the centre of the spindle carrier shaft to spur gear wheels attached to each of the work spindles. The second branch is taken through worm gearing to the change feed gear-box, driving the cam shaft from which the movements of the tool slides and the indexing movements of the spindle carrier are derived. The spindle speeds are varied by means of removable

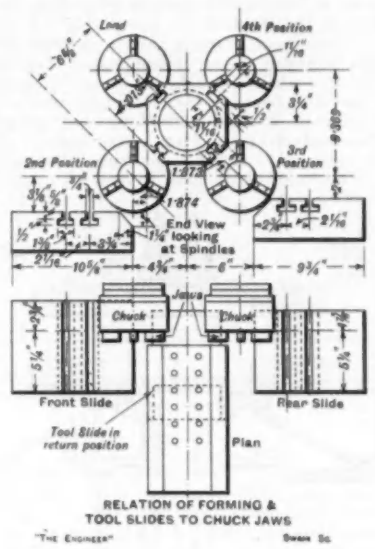
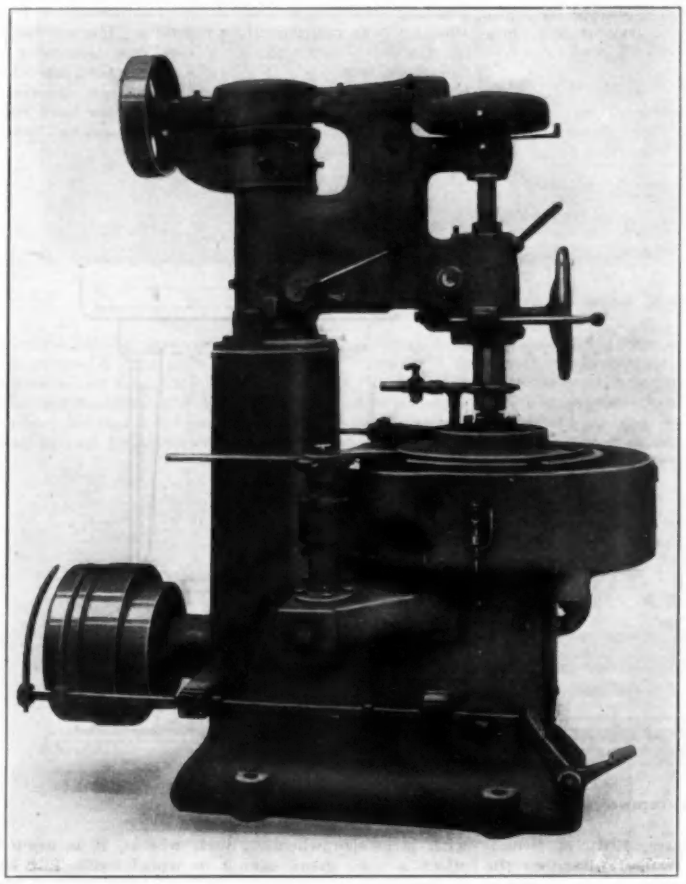
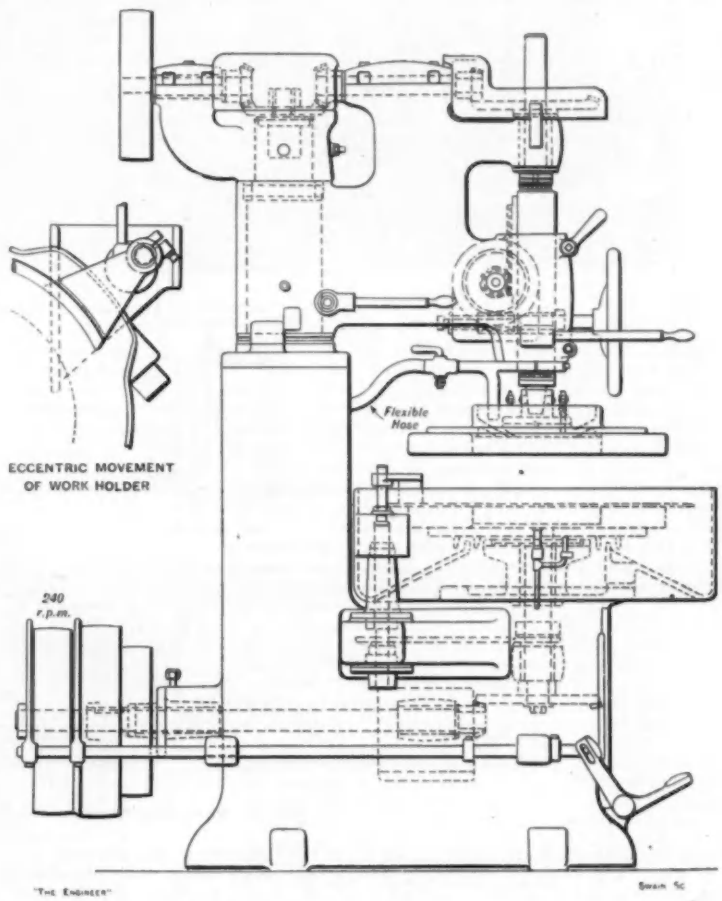


FIG. 18—TOOL SLIDES AND CHUCKS

gear wheels on the main driving pulley shaft. The cam drums are mounted on one shaft at the rear of the machine. This shaft makes four complete revolutions for one revolution of the spindle carrier. It is provided with two feed drums, one for the main tool slide and one for the cross slides. The method of feeding the cross slides is shown in Fig. 17. The rear cross slide is operated directly from the cam drum by means of a bell crank lever having a roller at one end and a fine adjustment screw at the other. The front slide is operated from a second cam on the same drum. The cam roller in this case is carried on a





FIGS. 19 AND 19A—UNIVERSAL LAPPING MACHINE—B.S.A. TOOLS

spindles is the loading position. During the loading operation the movement of the chuck being loaded is stopped by the use of a lever which in certain cases may also simultaneously open the chuck for the withdrawal of the finished part and the insertion of a fresh one. If the chucking operation is awkward the feed drive. The two ends of the housing are coupled together by a channel-sectioned cast iron top plate to give rigidity. On this top plate a guide is formed for a slide which supports the outer end of the live or tapping spindles when they are in use. The central shaft of the spindle carrier extends through horizontal longitudinal bar formed with a rack at its end. This rack engages with the lower of a pair of united pinions. The upper pinion engages with a second rack formed at the end of a rod, which extends across the bed of the machine and which is attached to the front slide through a fine adjustment. The

cam shaft is driven through worm gearing for the cutting feeds. For the return movements of the slides and the indexing movements of the spindle carrier its speed is increased automatically by the action of a clutch. A double-deck type of tool holder may be fitted to the rear cross slide to enable work in the fourth position—Fig. 18—to be machined with a forming or recessing tool. The lubrication of the machine is effected by means of a chain driven pump drawing its supply from a reservoir in the base. As each spindle arrives at the top front, or loading, station, its bearings receive a supply of oil which is sufficient to lubricate it until it returns to the same position at the start of the next cycle. A separate chain driven pump drawing from a separate reservoir supplies lubricant to the cutting tools. The machine can chuck work up to 4½in. in diameter, and has a main tool slide feed of 6½in. It is also produced in a form adapted to the manufacture of components from bar material up to 2½in. in diameter.

The universal lapping machine—illustrated in Figs. 19 and 19A—is designed to deal with such pieces

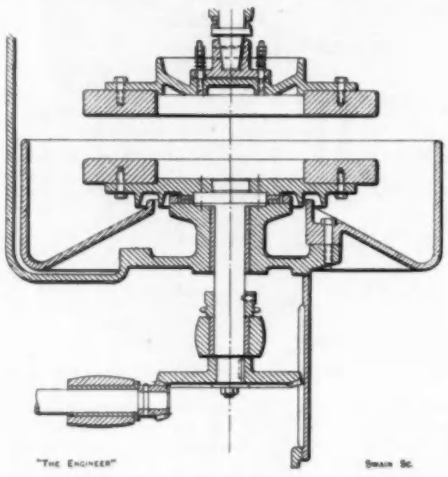


FIG. 20—SECTION OF LAPS AND PAN

as gudgeon pins, piston rings, valve tappets, and small shafts, such as are used in speedometers, clocks, sewing machines, &c. It is claimed to give a high finish and great accuracy to the parts submitted to its action and to remove the minute surface imperfections left by the grinding machine. The parts to be dealt with are held in a holder between two contra-rotating laps, and in that position are subjected to a copious supply of abrasive solution. The holder is specially designed to suit the parts to be lapped, but otherwise the machine is universal in its character. For piston rings, the faces of which are to be lapped, the work holder consists of a circular plate fitting above the lower lap and having nine or so circular holes in it, into which the piston rings fit easily. For cylindrical parts with holes through them the work holder takes the form of a ring with inwardly projecting spokes over each of which a part is slipped. For solid pins the work holder consists of a plate with slots cut in it for the reception of the pins. In each case the work holder is given an oscillatory movement by means of two excentric spindles mounted one on each side of the machine. The amount of this oscillatory movement can be adjusted. Its object is to make the work pass over the entire surface of the laps. Provision is made for raising and lowering the upper lap and, when it is raised, for swinging it clear of the lower lap to facilitate loading. The upper lap in the working position floats on its support in order to secure self alignment with the lower lap and to ensure uniform wearing of the laps. The abrasive solution is contained in a tank constructed with a sloping bottom and fitted with an agitator to maintain the abrasive in suspension. From the tank the solution is pumped through a flexible hose into a saucer at the centre of the upper lap holder, whence it flows through a sloping passage to the interior of the two annular shaped laps. The successful working of a machine of this description depends very largely upon the efficiency of the measures taken to prevent the lapping solution from reaching the bearings and wearing parts, and in particular the bearings beneath the lower lap. The cross-section given in Fig. 20 illustrates the design of the pan into which the abrasive solution flows from between the laps and the baffles which prevent it from reaching the lower bearings. The laps are 24in. in outside diameter, and have a working face 6in. wide. The output of the machine depends entirely upon the nature of the work lapped, and the amount of material left for lapping. A common allowance for lapping is 0·0002in. to 0·0004in. With this allowance small gudgeon pins ⅜in. in diameter by 2½in. long could be lapped in batches of thirty-six at a time, each batch being completed in from 10 to 15 minutes.

THE CHURCHILL MACHINE TOOL COMPANY, LTD.

Several precision grinding machines, two at least of them of entirely new design, are shown by the Churchill Machine Tool Company, Ltd., of Broadheath, near Manchester. In several instances the machines are provided with hydraulically operated traversing motion, a system which, the makers claim, not only makes the machines much easier to operate, but which gives a practically infinite variation of speed between the maximum and the minimum. In certain recent American and German vertical spindle surface grinding and internal grinding machines the motor driving the grinding wheel is placed directly in line with the wheel spindle. This arrangement gives a neat design, but Messrs. Churchill contend that the small space available prevents the fitting of a motor of adequate power, and, in addition, that the spindle cannot be made as massive as when the motor is not placed in line with the wheel spindle. The company informs us that it has made both types of grinder, and, to give a particular instance, has proved conclusively that a 60 horse-power motor can be used to advantage with a 24in. segmental grinding wheel, but that a 60 horse-power motor cannot be applied directly on the spindle. In Fig. 21 we reproduce a drawing showing the company's method of driving the wheel of a vertical spindle surface grinding machine. It will be seen that the motor is mounted on a floor plate and that the transmission is taken through bevel gearing to a vertical back shaft, and thence by belt to the spindle of the segmental wheel. The machine illustrated is fitted with hydraulic traverse to the table. It is of an entirely new model, the first of which has been built expressly for the Exhibition. Because of the late date of its completion, we are unable for the present to describe the details of its construction.

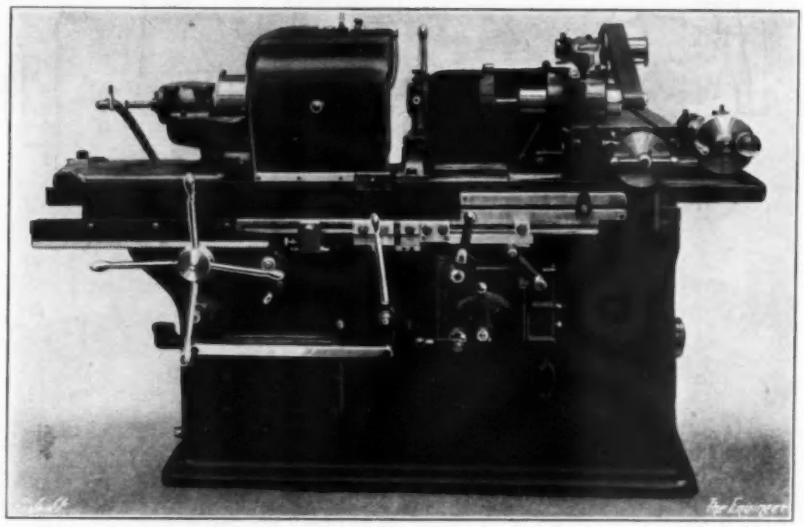


FIG. 22—"INTERMATIC" INTERNAL GRINDING MACHINE—CHURCHILL

Another new machine shown by the company to which the visitor interested in the development of grinding practice should direct his attention is a 10in. by 36in. plain grinding machine. The outstanding feature of this machine is the large diamenter of the wheel employed. The machine is, in fact, intended to compete with the products of certain American manufacturers, who during recent months have concentrated on the production of small grinders fitted with large-size wheels. Such wheels, it is argued, effect a very great saving in wheel costs, but the Churchill Company hesitated to fit them until it had satisfied itself that on small machines spindle bearings of a size adequate to the size of the wheel could be provided. In the machine shown at Olympia the wheel head and spindle have been designed to give the extreme rigidity required to carry a large wheel satisfactorily. The wheel head is, in fact, as heavy as some makers use for their heavy roll grinding machines. The wheel drive is enclosed, and the wheel

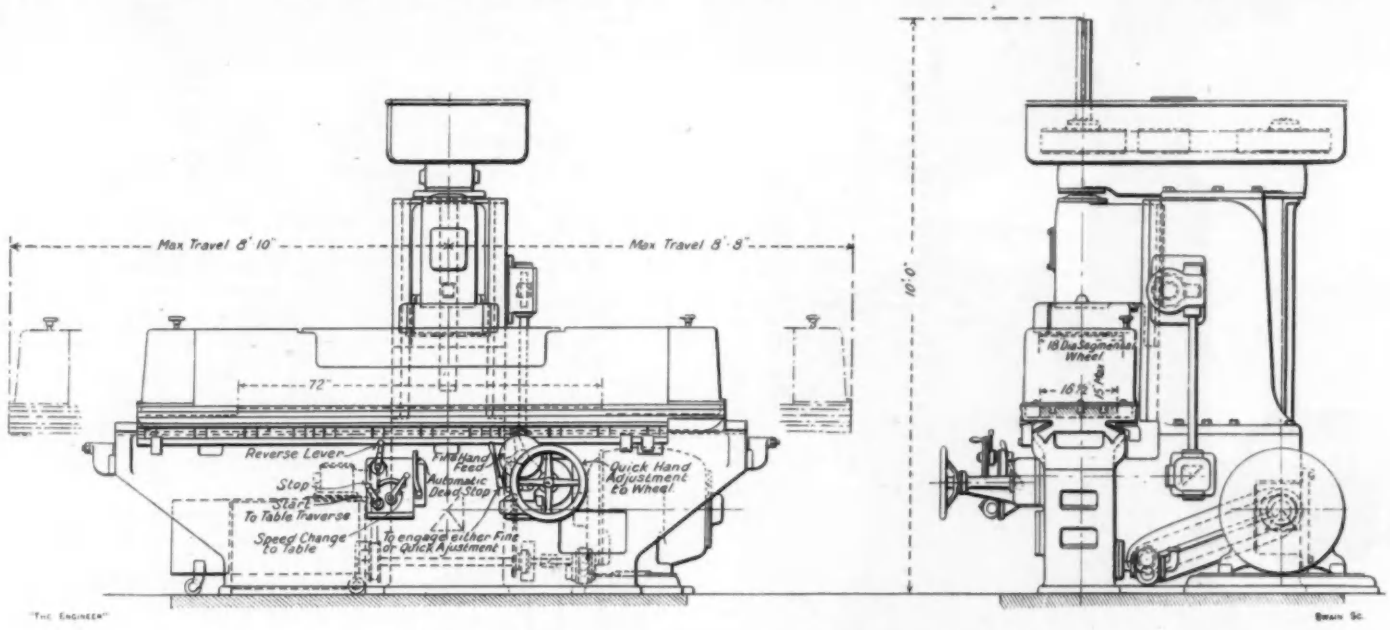


FIG. 21—VERTICAL-SPINDLE SURFACE GRINDING MACHINE—CHURCHILL

head is fitted both with a quick hydraulic in and out movement, and with a fine hydraulic feed. Hydraulic power is also used to traverse the table. The machine is claimed to be particularly useful for high production work on relatively small parts, such as those originating in the automobile industry.

A third Churchill machine containing several features of novelty is an "Intermatic" internal grinding machine fitted with an automatic sizing mechanism. This machine may be described by reference to Figs. 22 and 23, which show a slightly earlier design to that exhibited. The automatic sizing mechanism operates in such a way that after the first hole has been ground to size, succeeding holes are ground to the same size within fine limits. The machine can deal with holes up to 10in. in diameter. The makers admit that the machine is not so elaborate as an excellent machine of the same type made by a well-known American competitor, but they claim that their British-made product is simpler to set up, less likely to give trouble, and is much more adaptable in changing from one job to another. A hydraulically operated traversing work table fitted with a quick hydraulic withdrawing movement carries the work head on a double swivel base, the upper part of which gives a coarse adjustment up to 30 deg., and the lower a sensitive adjustment for exact parallel or taper grinding. In the machine exhibited the work head is driven by a motor mounted directly on the work head casting, and not by belt from a drum on an overhead countershaft, as shown in Fig. 23. The grinding wheel spindle is mounted on a heavy stationary cross-slide, fitted with an automatic cross feed, in addition to a fine hand feed and a quick adjustment. The automatic feed is operated by a cam device, which is such that after the hole has been rough-ground the wheel is automatically withdrawn from the work for truing against a diamond tool. When the finishing size of the hole ground can, it is claimed, be maintained constant within limits of 0·0002in. and 0·0003in. In the machine shown at the Exhibition the diamond wheel dresser is fitted with a hydraulic movement. After the rough grinding operation has been completed, the movement of a lever places the grinding wheel and the diamond tool in the truing position. At the same time the table is automatically slowed down to the correct truing speed, and continues to reciprocate at this slow speed until the operator considers that the wheel has been correctly trued. The return movement of the lever restores the wheel to the grinding position for the finishing cut has been taken with the trued wheel and the work has been brought to size, the wheel is again automatically withdrawn from the work. The quick adjustment is provided for positioning the wheel relatively to the work, and the fine hand feed is employed to compensate for the reduction in the size of the wheel. After the first hole has been ground to size the operations performed on the second and subsequent pieces consist of chucking the work, rough grinding the hole, truing the wheel, finish grinding the hole, and removing the work. So long as the grinding wheel is not allowed to become glazed, the operation. The makers claim that it is better to leave the operator to decide how much truing to give the wheel rather than to make the truing process wholly automatic. If the pieces being ground are very irregular in the size and shape of their bores, the operator can vary the amount of truing in accordance with the amount of material removed from the last piece ground. The guards on the machine should be noted. The water guard over the work is hinged, and when the work table is withdrawn from it, the water supply is automatically cut off. A swinging guard is provided over the grinding wheel, and is brought automatically into position when the table is withdrawn.

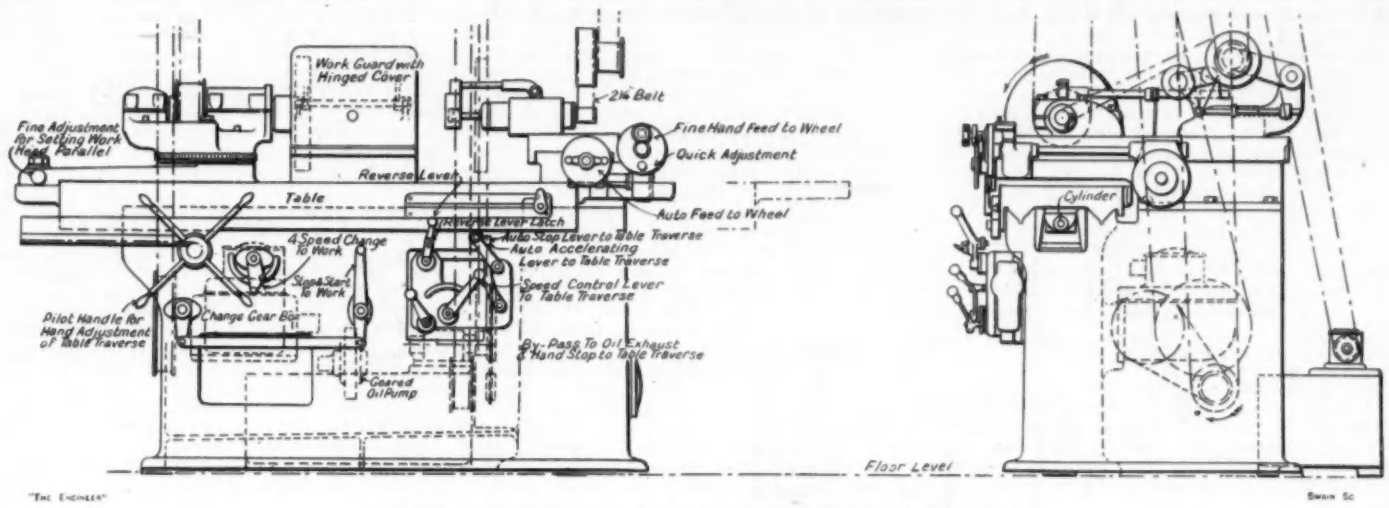
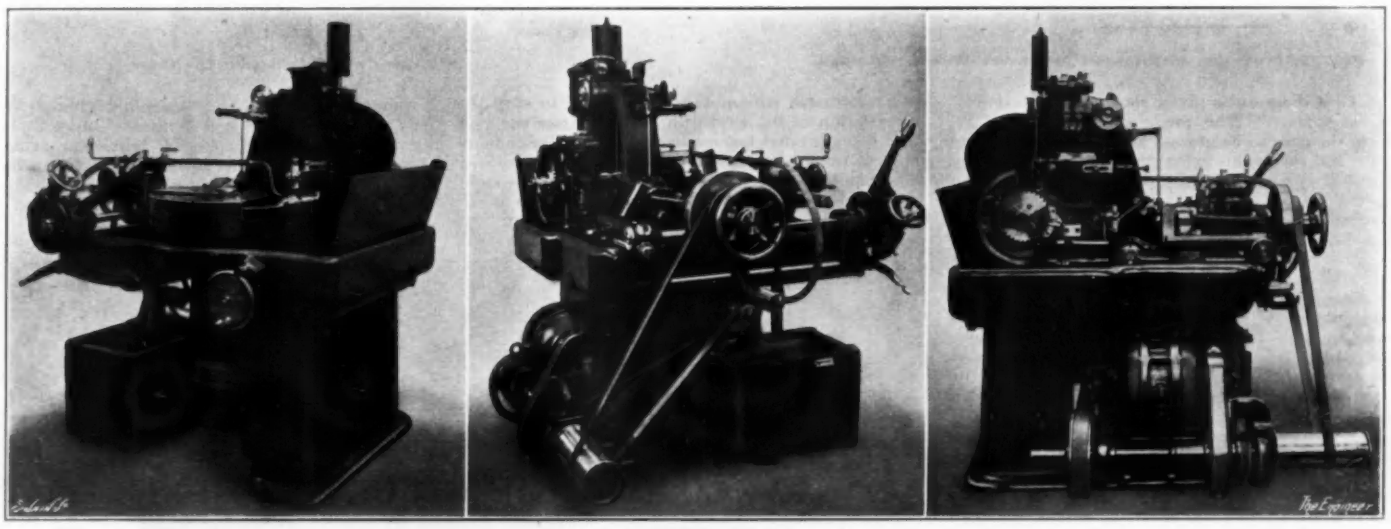

Work Guard with Hinged Cover
2¼ Belt
Fine Adjustment for Setting Work Head Parallel
Fine Hand Feed to Wheel
Quick Adjustment
Reverse Lever
Table
Auto Feed to Wheel
Driving Dog Lever Latch
Auto Stop Lever to Table Traverse
4 Speed Change to Work
Auto Accelerating Lever to Table Traverse
Stop Start to Work
Speed Control Lever to Table Traverse
Pilot Handle for Hand Adjustment of Table Traverse
Change Gear Box
By-Pass To Oil Exhaust & Hand Stop to Table Traverse
Geared Oil Pump
Cylinder
Floor Level

FIG. 23—"INTERMATIC" INTERNAL GRINDING MACHINE—CHURCHILL



FIGS. 24 TO 26—GEAR WHEEL GRINDING MACHINE—CHURCHILL

Among the other machines exhibited by the Churchill Company is the gear-grinding machine—shown in Figs. 24–26. This machine is intended to operate at high speeds on spur gear wheels and pinions before or after hardening. The principle employed to impart the correct form to the ground teeth makes use of a large master tooth or cam produced by a generating process, and having the desired involute or modified involute form. The grinding wheel is of large diameter and is mounted on a fixed vertical spindle carried by a slide, which, for the purpose of putting on the cut, is provided with a vertical adjustment through a graduated hand wheel fitted with a dead stop. A grinding wheel truing device is mounted on the heavy guard surrounding the wheel, and by means of it the working face of the wheel can be maintained at right angles to the grinding wheel spindle and parallel with the axis of the work spindle. As a consequence, the gear teeth are at all times ground truly parallel. The work spindle on which the gear to be ground is mounted is supported horizontally in bearings on a slide carried on an upright. This slide is reciprocated vertically on the upright

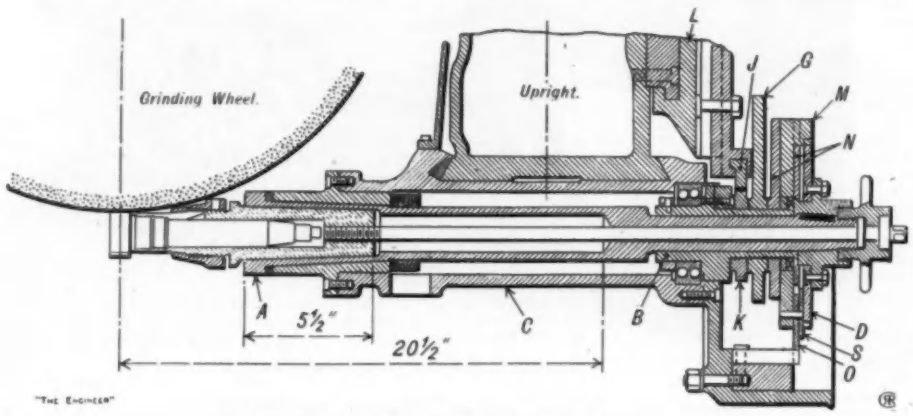


FIG. 27—WORK SPINDLE OF GEAR WHEEL GRINDER

through a constant length of stroke by means of a crank shaft in the base of the upright. In addition, the upright has imparted to it a horizontal reciprocating movement, which traverses the tooth being ground across the working face of the wheel, and thereby distributes the work over a large area and promotes the longevity of the wheel.

A sectional drawing of the work spindle is reproduced in Fig. 27, and an end view in Fig. 28, while plate S, which is attached to and moves with the plunger M and trip O.

On the downward stroke of the work spindle slide the plunger M re-engages with the index plate, the pawl R lifts clear of it, the work spindle rotates anti-clockwise under the force communicated to it by the spring-controlled rack J, and the work is presented to the grinding wheel exactly as previously except that it has been indexed one tooth onwards.

the departure from strictly accurate setting which accumulates as a result of the successive settings of unground wheels from the ground wheels which have preceded them through the machine.

The Butler Machine Tool Company, Ltd.

On the stand of the Butler Machine Tool Company, Ltd., of Halifax, several new designs of machines are to be noted.

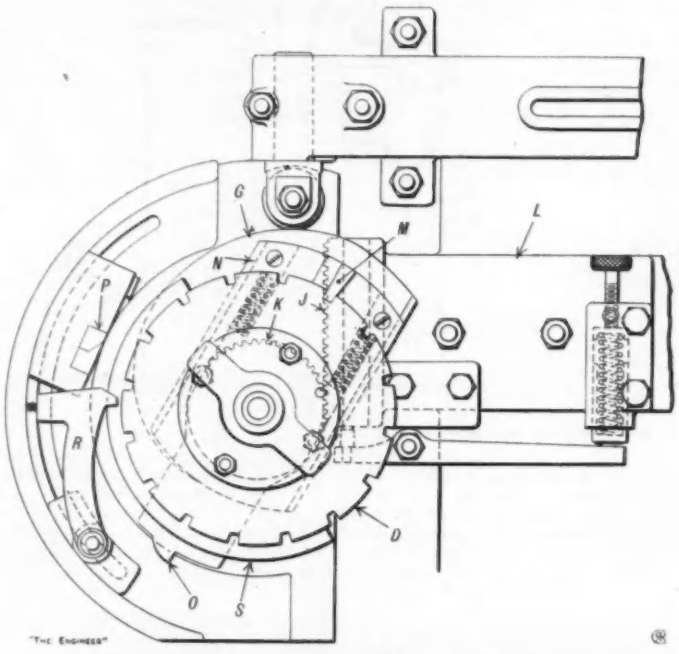


Fig. 28—Indexing Mechanism of Gear Wheel Grinder

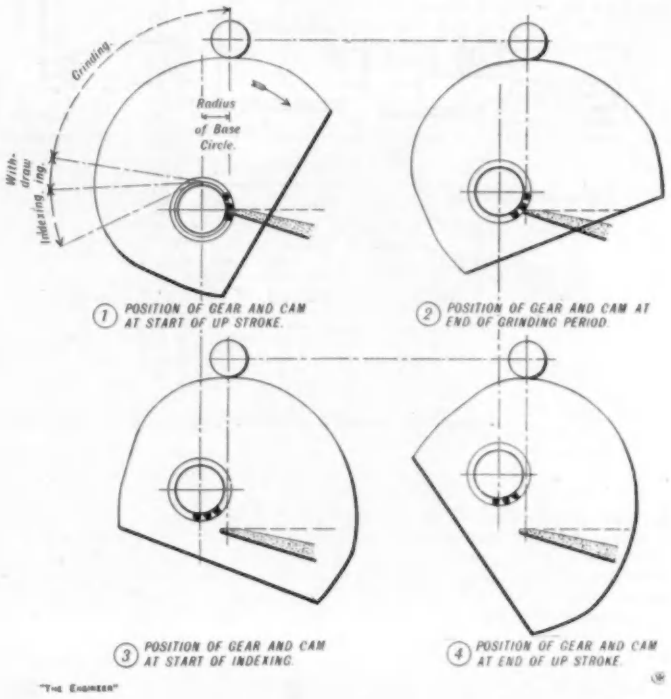

Grinding
Radius of Base Circle.
With-drawing
Indexing
1 POSITION OF GEAR AND CAM AT START OF UP STROKE.
2 POSITION OF GEAR AND CAM AT END OF GRINDING PERIOD.
3 POSITION OF GEAR AND CAM AT START OF INDEXING.
4 POSITION OF GEAR AND CAM AT END OF UP STROKE.
"The Engineer"

Fig. 29—Cam Movement Diagram

in Fig. 29 a diagram is given showing the action of the arrangement. The inner spindle A, Fig. 27, supports the gear to be ground at one end, and at the opposite end carries an index plate D. At the index plate end it is surrounded by an outer spindle B, on which the master involute cam G is mounted. The edge of the cam is maintained in constant contact with a roller at the end of an arm attached to the side of the upright. This arm can be adjusted horizontal, and is set in such a position that the centre of its roller is off-set from the vertical centre line through the work spindle by an amount equal to the base circle radius of the gear wheel being ground. As the arm is attached to the side of the upright it moves horizontally in common with the upright and the work spindle, but it does not move vertically with the reciprocation of the work spindle slide C up and down the upright. Consequently on the upstroke of the slide C the int raction of the cam and the roller produces a partial rotation of the work spindle in the clockwise direction. The cam is maintained in contact with the roller by means of a rack J and a gear wheel K—see Fig. 28. The wheel K is fixed to the cam and the rack J is acted upon from below by a lever and spring, which tend to force the rack upwards, and therefore to rotate the work spindle anti-clockwise. The actual clockwise rotation of the work spindle forces the rack downwards and therefore increases the compression in the spring acting upon it. This increase in compression is undesirable, for it would result in an increasing pressure between the roller and the cam, which would probably give rise to a variation in the rolling movement. In order to keep the spring compression, and therefore the roller contact pressure, constant the rack J is mounted in a slide L, which reciprocates vertically through the same amount as the work spindle slide but in the opposite direction. In other words, as the rack is forced down the slide L moves down with it, the lever remains horizontal and the compression of the spring is maintained constant at the value determined by the adjustment of the knurled knob above it.

The upward movement of the work spindle slide continues some distance beyond the point at which the point of the gear tooth being ground leaves the edge of the grinding wheel—see Fig. 29. During this additional movement the gear wheel is indexed to the next tooth. Over the grinding portion of the stroke the index plate D is engaged by a plunger M—Fig. 28—working in a slide N, which is fixed to the face of the master cam G. The plunger is extended right across to the opposite side of the index plate, and terminates in a tripping piece O. Just after the conclusion of the grinding portion of the upstroke the trip O makes contact with the pawl P, and the plunger M is withdrawn from its notch in the index plate. As it withdraws a locking pawl R engages with the index plate and holds it and the wheel being ground against rotation during the remainder of the upward stroke of the work spindle slide. The movement of the pawl R is governed by a semi-circular

An automatic trip motion is provided to stop the reciprocation of the work spindle slide after the gear wheel being ground has made one, two, three or more complete revolutions. A quick hand motion working in conjunction with dead stops can then be brought into action to withdraw the gear wheel from the grinding wheel, in order to facilitate its removal and replacement. A micrometer setting device is fitted at the gear wheel end of the work spindle. This device enables the position of the wheel to be ground to be quickly duplicated with the position of the wheel that has just been ground. The micrometer adjustment on the devi.e is provided to allow for

Among several shaping machines shown by the firm the 32in. stroke ball bearing "super" shaper, illustrated in Fig. 30, deserves particular attention. This powerful and robust machine is distinguished by its large capacity and the new features embodied in its design. Its body consists of a well-ribbed rigid casting bolted to a base-plate. The slides in which the ram works as well as the slides of the ram itself are formed of chilled metal. The ram slides are of vee formation and are engaged by a pair of loose cast gibs, one of which is bolted solidly against a strong square flange, while the other is adjustable for taking up the wear. The makers point out that vee slides,

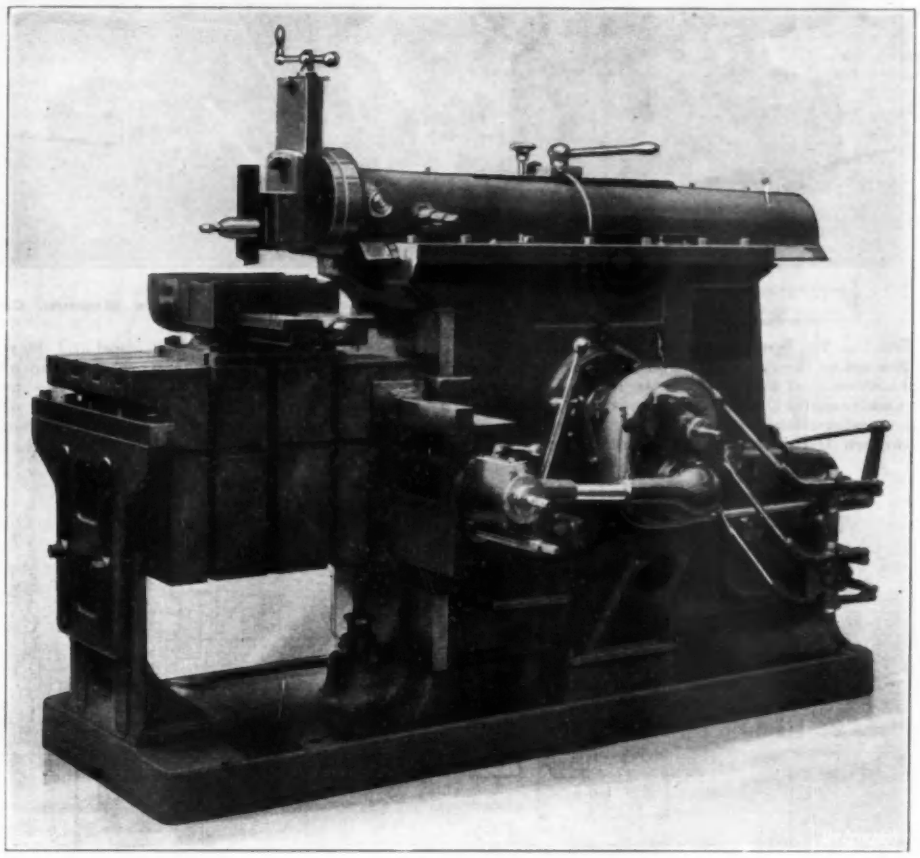


Fig. 30—32in. Stroke "Super" Shaping Machine—Butler

when cast with the bed, are difficult to scrape to the correct form and, in addition, often contain defective metal at the apex of the angle. With the design adopted in this machine the sides of the slides formed by the two loose gibs are chilled and ground. The lubrication of the ram slides is effected by means of wicks dipping into covered oil reservoirs formed in the gibs. Felt wipers are provided, and by means of oil catchers at the rear end of the ram the surplus oil is collected and returned to the gear-box. The ram is operated by a closed-end crank lever fitted with a hard bronze die. The ram stroke can be altered while the machine is running by means of a handle at the front which operates a screw and nut in the crank block. The crank pin and block are machined in one piece from a solid steel bar. The position of the stroke relatively to the work may also be altered while the machine is running.

The details of the driving and feeding mechanism are worthy of special study. The machine is driven by a 12 horse-power constant-speed motor, which transmits power through a "Fabroil" pinion to a large reduction wheel, to the face of which a friction clutch combined with a brake is fitted. The clutch and brake are operated from a handle at the front of the machine. From the clutch the drive passes through an eight-speed gear-box giving a range of from 4·5 to 65 cycles per minute. The gear changes are effected by means of handles on the working side of the machine. These handles are interlocked to prevent a foul, and as they are close to the clutch and brake handle they permit the operator to control the machine and change its speed with, the makers claim, not required is disengaged by a device which lifts the quadrant off the slide. The table is elevated by a telescopic screw which avoids the necessity for providing a hole in the ground. The outer edge of the table is supported by a bracket bearing under its front edge and adjustable vertically on a support bolted to the base-plate. With the table removed work may be bolted to the tee-grooved apron on the cross slide. A swivel base vice with steel-faced jaws capable of being opened to 15½in. is provided and can be bolted to the tee-slotted table or to the apron.

Another new design exhibited is the tilting body slotting machine, illustrated in Fig. 31. The general details of this machine are similar to those found in the standard design of Butler slotting machine. The novelty lies in the fact that the body is made in two parts, which are hinged together so that the upper part may be tilted forwards or backwards through 10 deg. or so. The upper part is rotated on its pivot by means of a worm and segment and has a rigid tail piece which, when it is locked to the base of the lower part, is claimed to secure the two portions together as solidly as if they were cast in one piece. An index is provided which enables the operator to tilt the body to the required angle with little trouble. The tool holder is of an improved rotating type, which is such that the tool may face four different ways, namely, to the front, back, or either side. The tool is given relief on the return stroke, but if the nature of the work will not permit relief to be given the relieving motion may be locked. The tools can be fixed in the holder either horizontally or vertically. The machine exhibited has a stroke of 8in. and can be operated at clearance. The table moves on vee slides fitted with automatic lubricators and is held down by gibs on both sides. The upright is bolted and tongued to the main bed and is provided with bearing surfaces on two sides for the saddle. The saddle is fitted with a quick-locking device and can be easily adjusted vertically by means of a hand crank. The tool-box is of the planing machine type and is fitted with an automatic feed and a hand adjustment both vertically and along the cross slide. It has a graduated swivel base and the front part may be fixed in any position, a feature which is designed to avoid the use of bent tools. The feed motion is derived from a vertical rack operated by a slotted crank disc. It is definitely synchronised with the table stroke and requires adjustment only for the amount and the direction of the feed. The machine as exhibited is driven by a 10 horse-power constant-speed motor. The drive is transmitted to the table through change gearing inside the bed, giving six speeds ranging from 6 to 57 cycles per minute. A friction clutch is embodied in the drive for starting, stopping, and inching the table. A brake motion is fitted to enable the operator to arrest the table instantaneously at any point.

HERBERT HUNT AND SONS.

Three types of twist drill point-sharpening and point-thinning machines are shown by Herbert Hunt and Sons, Old Trafford, Manchester. The example illustrated in Fig. 33 is the standard type, and is capable of dealing with two-lipped drills, ¼in. to 2in. in diameter and having any cutting angle from 90 deg.

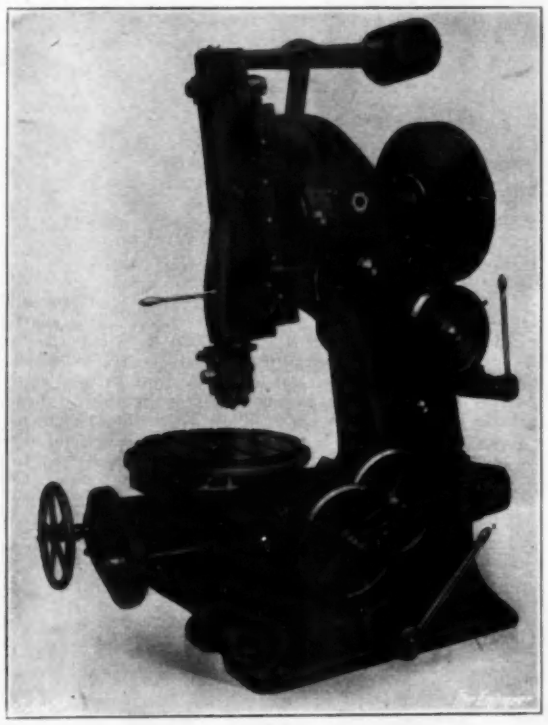


FIG. 31—TILTING BODY SLOTTING MACHINE—BUTLER

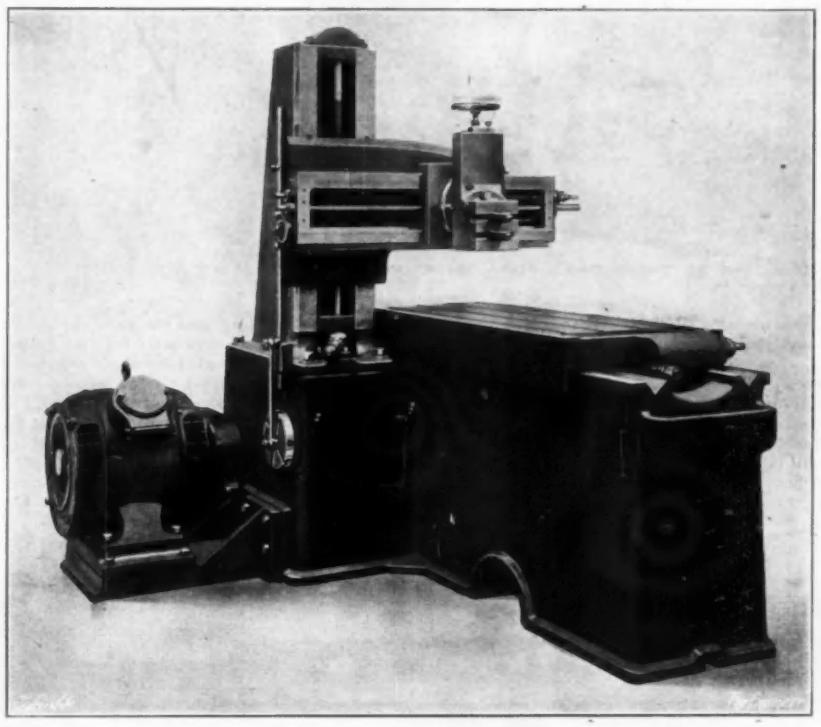


FIG. 32—OPEN-SIDED PLANING MACHINE—BUTLER

the facility and pleasure attending the change of gearing in a high-class motor car. On a brass plate fixed to the side of the body indications are given of the best speed for a given stroke on a given metal. All the shafts in the gear-box are carried in ball bearings and the wheels are automatically lubricated. Ten rates of feed varying from nine to ninety cuts per inch are obtained from a cam-operated self-acting feed motion. The feed box is supported on a bracket secured to the bed of the machine and designed to relieve the side of the frame of undue stress. The feed is selected, engaged, or stopped by the movement of a single lever. To reverse the feed a selector lever is provided at the end of the table slide. A quick-power traverse is fitted to the horizontal movement of the table. This traverse is controlled by a selector lever which, when moved, disengages the self-acting feed motion before applying the power traverse. An additional safeguard is provided in the form of an arrangement which ensures that the power traverse, when it comes into action immediately after the self-acting feed has been in use, moves the table in the direction required to withdraw the work from the tool.

The tool-box is of the single-screw type and is fitted with a graduated swivel front. It is of forged steel, as is the vertical slide, a feature which is claimed to add greatly to the efficiency of the machine by eliminating breakages and reducing the weight of the parts to be reversed at each stroke. The tool-box has a vertical adjustment of 9in. and is provided with a self-acting vertical feed derived from a friction quadrant which takes its motion from a flat slide lying alongside the ram slide. This feed motion is self-adjusting to the length of the stroke, and when it is four speeds. It is equipped with a table having a working face 20in. in diameter and capable of being traversed 1ft. 3½in. in one direction and 1ft. 1½in. in the other. It is claimed for the machine that while it retains all the cutting power and efficiency of an ordinary slotter for general work, it can be quickly and accurately set for dealing with either external or internal tapers. In other designs of taper slotting machine the ram has been tilted forward at the top end. This plan, Messrs. Butler contend, introduces a grave weakness into the driving mechanism at its most vulnerable point, and in any event only permits external tapers to be dealt with. In other designs of taper slotting machine a tilting table has been used. In this arrangement it is held to be objectionable that the table should be lifted off its slides while, as in the first alternative, only one form of taper can be machined. In the Butler tilting body machine those parts which it is essential for good and accurate work should remain stationary are not tilted, and the work may be slotted to a taper on either side of the vertical.

A third new machine on the Butler Company's stand is the 24in. stroke open-sided crank planing machine, illustrated in Fig. 32. This machine is intended to combine the ease of operation and quickness of a shaping machine with the capacity and accuracy of a planing machine. The stroke of the table is given by a motion similar to that found in a shaper, namely, by a slotted link lying inside the bed. The movement has a quick return and the length of the stroke may be varied from 2in. up to 24in. while the machine is running. In addition, the position of the stroke may be adjusted to occur at any point on the 4ft. table. The stroke movement is claimed to be so definite that the tool may be operated without end for rivet drills to 180 deg. for flat end drills. The drill to be ground is held by its shank in a self-centring chuck. Its point is supported in a bush, one of a series of standard sizes provided with the machine. By means of a floating arrangement fitted to the chuck spindle, the drill is allowed to rest on the lower side of the bore in the bush, and consequently it is unnecessary to have an exactly fitting bush for each size of drill to be ground. During the grinding operations the drill revolves in the bush and by means of a combined swivelling and reciprocating motion, which is also imparted to it, the requisite clearance is given to the cutting edge. The amount of the clearance can be varied to suit the conditions met with in drilling hard or soft metal. The rotary, swivelling and reciprocatory movements of the drill are, in the machine illustrated, imparted to it by the rotation of the hand wheel to be seen towards the left of our engraving. This hand wheel is geared to the spindle by spiral gearing, which causes the spindle to make two revolutions per revolution of the hand wheel. At the lower end of the hand wheel spindle there is a crank which is linked by a connecting-rod to a bracket attached to the side of the machine. When, therefore, the hand wheel is rotated, the work head as a whole, and with it the drill, will swivel to and fro about a pivoting centre situated close to the drill point. Just beneath the hand wheel there is a cam which, through the agency of a lever and an adjustable block, imparts a reciprocating movement to the chuck spindle away from and towards the grinding wheel. Variation of the position of the adjustable block varies the amount of clearance given to the drill. The two-to-one ratio between the hand wheel and the chuck spindle results in the swivelling and reciprocating

movements of the drill being repeated twice for each revolution of the work, as is required in the case of a two-lipped drill. In one of the other machines shown by Messrs. Hunt the gear ratio can be altered to 3 to 1 and 4 to 1, so that either two, three or four-lipped drills may be ground on the machine. In the third type, either of these forms of drill may be ground with a fully automatic motion communicated to the work head. In all three machines any variation in the included angle of the drill point requires an adjustment of the bracket to which the crank of the swivelling motion is anchored. Sufficient adjustment is provided to accommodate all included angles from 90 deg. to 180 deg. The thinning of the drill point is accomplished by bringing the drill over into the correct position relatively to the thinning wheel lying alongside the main grinding wheel. This movement of the drill is effected by means of the horizontal hand lever projecting from beneath the cross slide. The drill does not require to be re-set. After one side has been thinned, it is rotated through 180 deg. by means of a dividing plate and latch, and the other side is thinned. The depth of the point-thinning cut is adjustable by means of a swivel movement of the thinning wheel. A centrifugal pump immersed in an easily removed tank on the column of the machine supplies the coolant to the drill point. Roller bearings are fitted to the main grinding wheel spindle and to the loose pulley of the belt drive, and ball bearings to the spindle of the thinning wheel.

Another type of machine shown by Messrs. Hunt is the automatic reamer flute milling machine illustrated in Fig. 34. This machine can deal with reamer blanks up to 2in. in diameter and 18in. in length overall, and can mill in them either straight or spiral flutes of equal or unequal pitch and of equal or unequa' depth. Further, it can be employed to flute reamers which are parallel, taper or part parallel and part taper. It can also be arranged to mill the flutes in twist drills with the depths of the flutes decreasing towards the shank end. The cutter arbor carries three cutters, and the dividing head has triple centres, so that three articles can be milled simultaneously. The machine works entirely automatically, and several can be attended to by one operator. The work is carried between centres on a sliding table. At the end of a cutting traverse, the table falls and lowers the work clear of the cutters. It then quickly returns to the starting position, and, after the work has rotated through the required angle, the table rises again and the next cut is taken. Detail views of this machine are given in Figs. 35–37. Fig. 35 shows the dividing mechanism at the end of the work head spindle. At the end of the return stroke of the table, a dividing clutch is engaged and causes a shaft carrying the crank pin D to make one complete revolution. Through the connecting-rod C the pawl P is given motion, and as a consequence the dividing plate A is rotated by an amount determined by the pitch of the spaces formed round it. Before the cut begins the dividing plate is locked by a spring-and-cam-operated plunger B. The spaces in the dividing plate may be equally or unequally pitched, but if they are unequal the pitches over the second half must repeat the pitches over the first, in order that the locking plunger may always have a space with which to engage. If the pitch of the flutes is irregular, their depth will in general also be different. The depth is controlled by means of a cam disc driven from the dividing plate spindle by a silent chain. The heights formed on this disc control the depth of cut. If the flutes are to be of equal depth, a plain disc is used in place of the cam disc. Fig. 37 illustrates the table-lowering mechanism and the taper-milling attachment. The rising and falling parts of the machine are counterbalanced. The bed on which the table slides is substantially a rectangular frame, which is mounted to rise and fall on a stout vertical column lying directly in alignment with a vertical line through the cutters. A bar is hinged to the lower right-hand corner—Fig. 34—of the frame. The inner end of this bar is fitted with a roller which rests on a small table supported from the pedestal of the machine. Close to the roller the hinged bar carries a short cross rod, one end of which is fitted with a cam block K—Fig. 37—and the other end of which is provided with a lever operated by dogs on the edge of the table. A roller at the lower end of a vertical shaft L bears against the cam block. For parallel work the shaft L is fixed relatively to the rectangular frame. Consequently the oscillation of the cam block K at each end of the table stroke will cause the frame and table to rise or fall as required for putting on or relieving the cut. For taper work the shaft L is freed from engagement with the frame and a roller at its upper end is brought into engagement with a former bar M attached to the edge of the table. As the cut proceeds, the shaft L

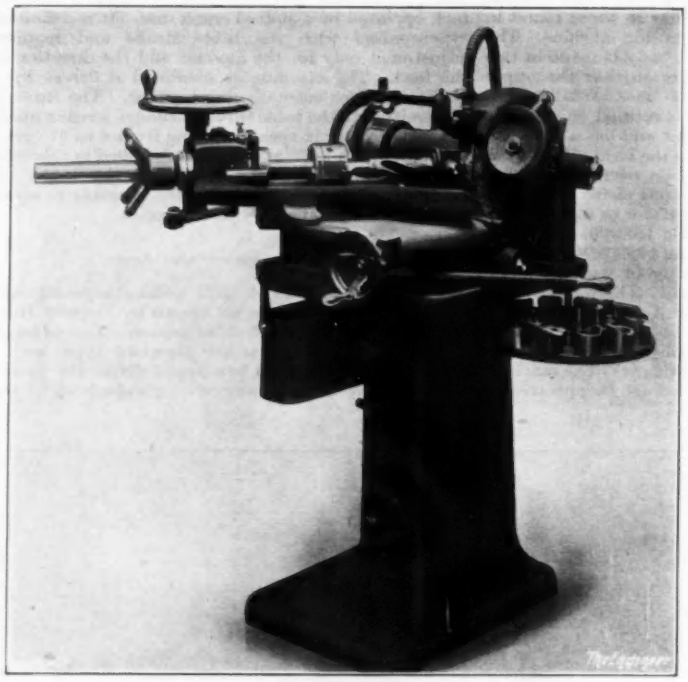


FIG. 33—TWIST DRILL POINT-SHARPENING MACHINE—HUNT

FIG. 34—AUTOMATIC FLUTE MILLING MACHINE—HUNT

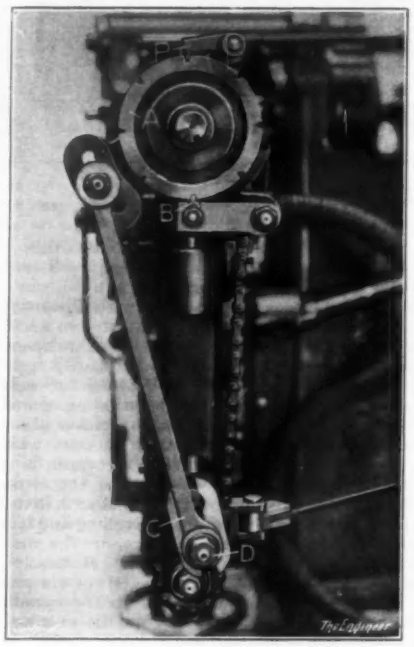


FIG. 35—DIVIDING MECHANISM OF FLUTE MILLER

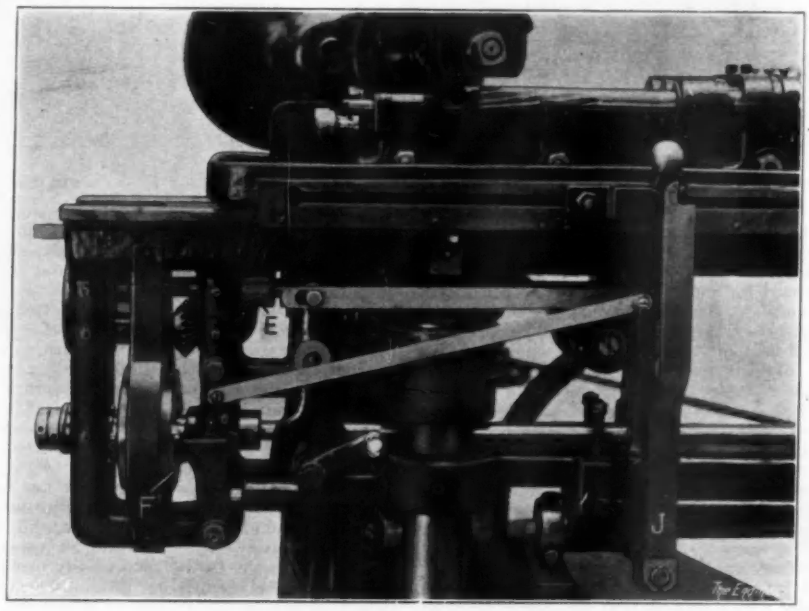


FIG. 36—TABLE REVERSING GEAR, FLUTE MILLING MACHINE

rises relatively to the rectangular frame, and therefore through the abutment of its lower roller in the cam block allows the frame and table to fall away progressively from the cutter. At the end of the cutting stroke the oscillation of the cam block results in the work returning clear of the cutter just as in the case of parallel reamers. In Fig. 36 the table-reversing gear is shown. The lever J operating the cam block of the table lowering mechanism also by its movements operates the clutches E F. The clutch E reverses the drive to the table. The clutch F is rendered active at the end of the return stroke and operates in conjunction with a latch which allows its shaft to make one revolution. This shaft extends along the rectangular frame, and at its other end carries the crank pin of the dividing mechanism—Fig. 35.

A third machine of considerable interest on Messrs. Hunt's stand is one designed for the production of wire drills in tool-rooms. The material chopped off

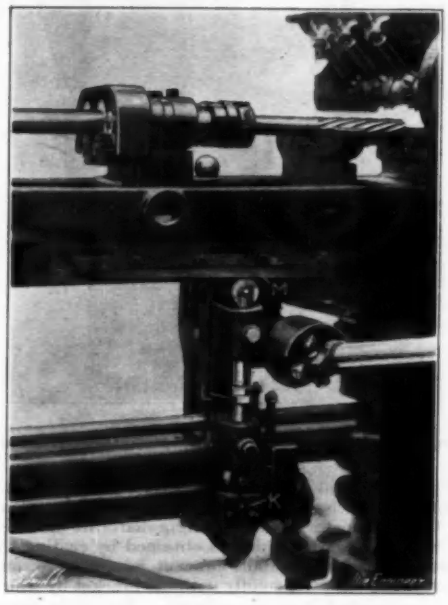


FIG. 37—TABLE LOWERING MECHANISM

to length is placed in a self-centring chuck, and while so held is grooved and then milled for clearance. Thereafter, the grooved and backed-off drill is hardened, sand-blasted, and ground to diameter. The machine is made in two sizes, one for drills up to ¼in. diameter and the other for drills up to ½in. An important feature of the design is a means for securing the instantaneous dropping away of the work at the end of the cut in order to prevent the drill being weakened by the dwelling of the cutter at the end of the flute.

THOMAS RYDER AND SON, LTD.

The six-spindle vertical automatic machine—Fig. 38—exhibited by Thomas Ryder and Son, Ltd., Turner Bridge Works, Bolton, represents a type of machine tool which has special claims to the attention of the motor car industry. The class of work coming within its capacity includes front and rear hubs, crown wheels, brake drums, differential cases and covers, axle case covers, gear blanks, couplings, and so forth. The pieces to be machined are held in chucks or between centres on a carrier, which can be indexed into six stations. In five of these stations tooling of the parts takes place. The sixth station provides the unloading and re-loading position. Round the central column of the machine there is a hexagonal slide, which can be fed vertically downwards. This slide can be arranged to carry either turning, boring, or drilling tools for operating on the work at any or all of the five tooling stations. In addition, there is a right and a left-hand horizontal slide, each of which can be fitted with forming tools to operate on the work when it is in the two adjacent stations. During its cycle through the machine each piece of work can in this way be operated upon by nine different tools or sets of tools. The spindle speed may be varied by change gearing, but at any setting all the spindles rotate at the same speed. If the speed selected is that suited to the forming or turning tools, it may be less than that which can be used with advantage for drilling. Accordingly, provision is made for fitting at any or all of the stations high-speed drilling spindles driven by an independent motor in a direction opposed to that in which the work rotates.

The machine is driven from a single pulley running at 500 r.p.m., or by an electric motor. From the pulley shaft, as shown in Fig. 39, the drive is taken through a pair of spindle speed change wheels to a main worm shaft. The worm on this shaft meshes with a worm wheel with which is united a large helical wheel. With this helical wheel, helical pinions on the spindles mesh. These pinions are to be seen in Fig. 40, which shows the indexing table from beneath. The change gearing provided with the machine gives sixteen different spindle speeds ranging from 25 to 148 r.p.m. The spindles are held in split excentric bushes, which not only permit adjustments to be made for wear in the bearings, but also allow the exact position of any one spindle to be set with extreme accuracy. In the first or loading station the spindles

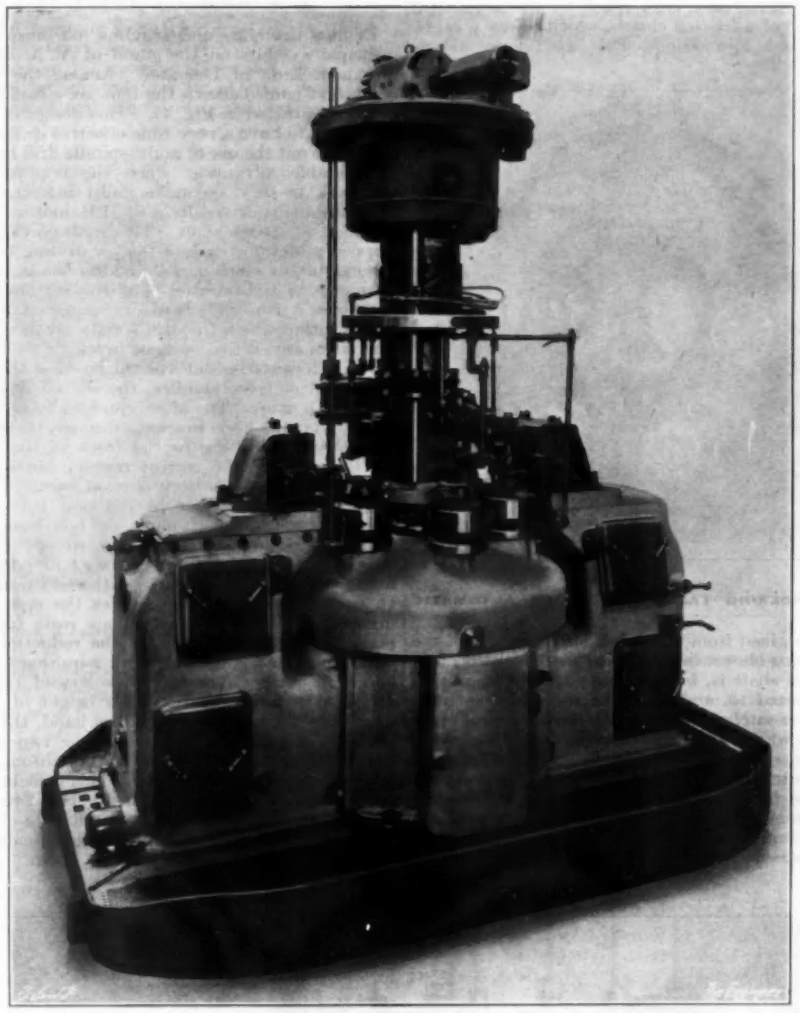


FIG. 38—SIX-SPINDLE VERTICAL AUTOMATIC MACHINE—RYDER

when they reach it are stopped automatically by means of a clutch. When the next indexing movement occurs the spindle is automatically restarted.

From the main worm shaft—Fig. 39—a train of change wheels transmits power to the feed worm shaft. Alteration of these wheels alters the feed of both the hexagonal central slide and the two horizontal slides, the wheels provided permitting fifteen changes of feed ranging from 18 to 193 cuts per inch. From the feed worm shaft power is transmitted to a vertical shaft through a worm wheel. This worm wheel is fitted with pawls which engage a ratchet wheel keyed to the vertical shaft. From this vertical shaft the power is taken to cam drums, which feed the three slides. A hand feed is also provided by means of a handle which can be wound into position until it is locked by a catch and thereafter may be turned in either direction. When the power feed is engaged the catch of the hand feed is automatically disengaged and the handle is pushed out of gear. The indexing of the table is effected by means of a cam situated on a shaft in the base, which makes one revolution per machine cycle. The cam operates an indexing rack which moves the table round by means of a single-tooth dog clutch, and a vertical shaft carrying at its top end a pinion which gears with a wheel fixed to the table. The dog clutch acts in one direction only, and when the rack is returned by a spring of the clock type, it sets itself for the next stroke.

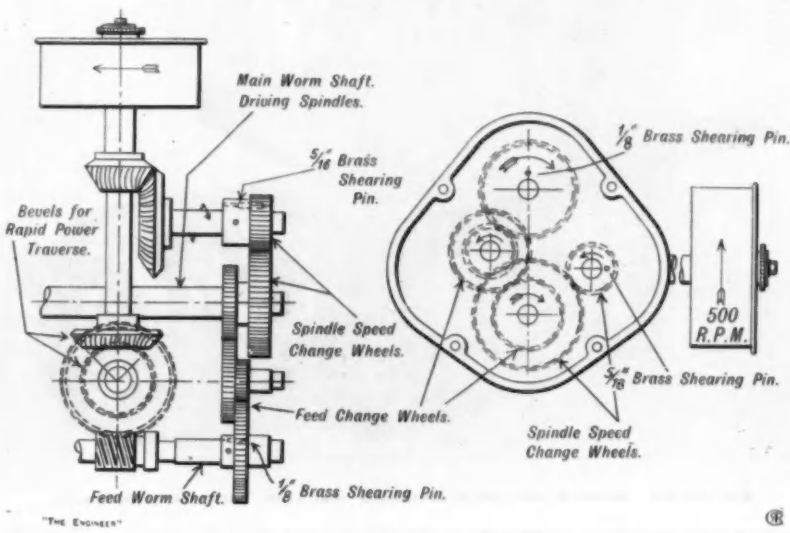


FIG. 39—FEED AND SPEED CHANGE WHEELS OF VERTICAL AUTOMATIC MACHINE

During the period of indexing the table, in order to reduce friction, is lifted off its seating by five or six thousandths of an inch. This lifting movement is accomplished by two sets of hardened steel rollers bearing beneath the edge of the table at the back and front, and raised at the correct instant by a cam situated on the slow-speed shaft in the base. The plunger determining the position of the table at the

six stations engages with sockets round the table edge—see Fig. 40—lying at a diameter which is more than twice that at which the turning tools work. In order to avoid any tendency for the table to overrun the plunger, the energy of the table towards the end of the indexing movement is absorbed by the compression of a spring. When the table is in the correct position, it is held there by a positive stop until the plunger is engaged in its socket. The indexing movement is operated at a high speed by the automatic engagement of a friction clutch, which brings a rapid power traverse into action. This rapid power move-

FIG. 40—INDEXING TABLE OF RYDER'S AUTOMATIC

ment is obtained from the pulley shaft by way of the bevel gearing shown in Fig. 39. The bevel wheel on the vertical shaft is, in fact, one part of the friction clutch referred to, and when the rapid movement is engaged the ratchet wheel on the same vertical shaft —through which wheel, as already stated, the power feed is transmitted—overtakes the pawls. When the friction clutch is disengaged, the pawls immediately take up the drive again. It will be gathered, therefore, that the engagement of the friction clutch not only applies a rapid movement to the indexing motion, but also speeds up all the feeds. As a result, the with work which cannot advantageously be handled by the forming tool slides. These automatic slides are attached to the central hexagonal slide, and can be set to move their tools vertically or horizontally or both in succession under the control of the downward movement of the hexagonal slide. A modified form of automatic slide can be fitted to deal with undercuts inside bores.

A. A. JONES AND SHIPMAN, LTD.

Drilling machines and grinding machines form the principal exhibits on the stand of A. A. Jones and Shipman, Ltd., of Leicester. Among the machines of the first-named class is the 18in. six-spindle multiple driller illustrated in Fig. 41. This design of machine is claimed to have a very wide effective drilling range, and to permit the use of multi-spindle drill heads with considerable advantage when the requirements of the work to be done make multi-drilling desirable. The machine is driven by a 6½ H.P. motor connected by chain to a back shaft. This shaft carries a three-stepped pulley for each of the six drilling heads. In the exhibition machine four of the heads are driven by means of right-angled belts taken from the back shaft over a pair of idlers to a two-stepped pulley on a sleeve within which the drill spindle slides on splines. The idlers are carried on knee brackets, which can be raised or lowered on slides on the backs of the columns by means of lever handles, the shafts of which are fitted with cams. The idlers can also be moved horizontally on the knee brackets through the agency of turnscrews projecting to the front of the machine. By these means the correct tension can be applied to the belt, whatever step it is on, and, in addition, by operating the lever handle and turnscrew the attendant is enabled to move the belt from one pair of steps to another. The six spindle speeds so obtained range from 497 to 2618 r.p.m. Two of the heads are fitted, in addition, with reduction gearing. In one case this gearing enables the spindle to be driven reversed at a three-to-one ratio for tapping purposes. In the other case the reduction ratio is two to one, and is used on work requiring low speeds and high power. The heads are spaced 12in. apart, and can be adjusted through a height of 9½in. In four cases the spindles are fed by hand, the range of the feed amounting to 6in. In the two remaining cases the heads are fitted with an automatic feed, which we illustrate in Fig. 42. This attachment provides three rates of feed, namely, 176, 240, and 333 revolutions per inch. It is operated by a chain drive taken from the main spindle, a swinging quadrant being used to obtain adjustment of the chain. From the panying the use of a diving key. The table of the machine exhibited has a surface of 72in. by 17in., and can be raised by a rack and pinion through a range of 21in. Beneath the table are two pedals, whereby the machine may be started or stopped instantly. A sump for the coolant is incorporated in the base of the machine. All the supply and return piping for the fluid is enclosed inside the machine column.

Another machine shown by the firm is the 25in.

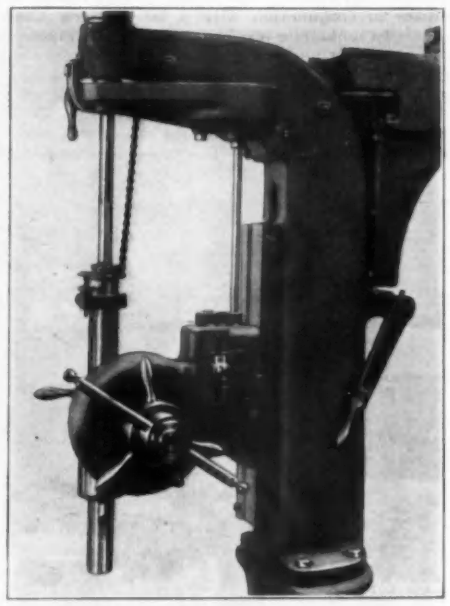


FIG. 42—AUTOMATIC FEED OF MULTIPLE DRILLER

all-geared sensitive driller illustrated in Fig. 43. This machine is capable of drilling holes in steel up to 1in. in diameter. All its running shafts are mounted in ball bearings. Rigidity is obtained by casting the column, head and spindle bracket in one piece, and by forming the table solidly with the bracket by which it is supported from the column. The table has a vertical adjustment of 20in., and the spindle a vertical feed by hand of 6in. A depth stop is fitted to the

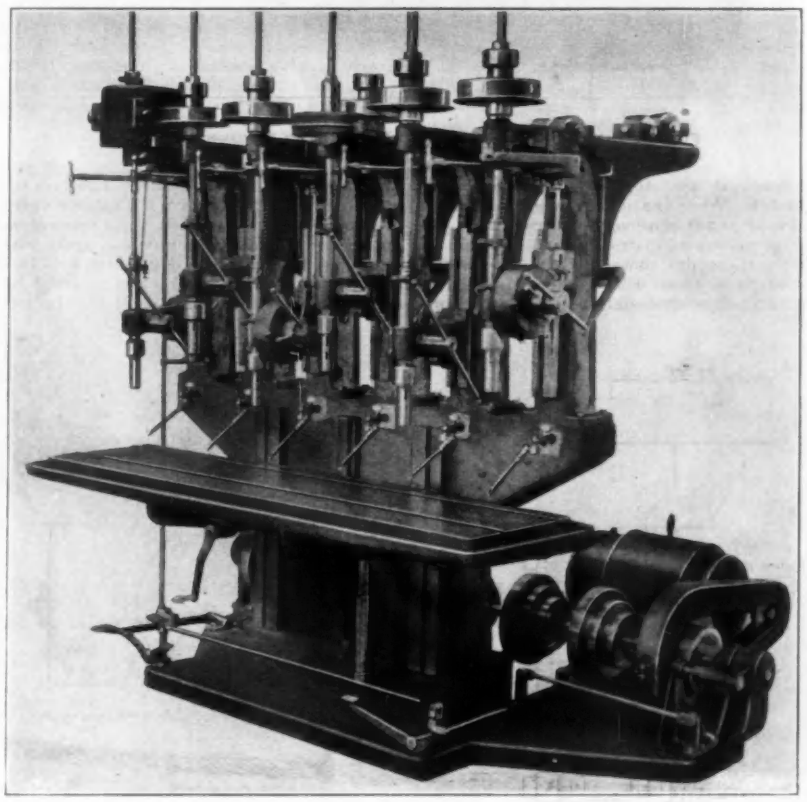


FIG. 41—SIX-SPINDLE MULTIPLE DRILLING MACHINE—JONES AND SHIPMAN

withdrawal of the tools from the work and their return —movements which are made simultaneously with the indexing motion of the table—are effected at high speed.

The engraving, Fig. 38, shows the machine fitted with a high-speed drilling spindle at the third station. The drive to this spindle is derived from a motor situated on top of the gear-box through which the feed is transmitted to the hexagonal slide. In addition to these high-speed drilling spindles, automatic cross slides can be fitted to the machine to deal spline shaft running down from the larger chain wheel the feed is transmitted to the quill of the spindle through sliding gear wheels and a worm and worm wheel. The gear change can be effected while the machine is running, the setting of the wheels being controlled by means of a knurled knob on the side of the gear case and a small pointer engaging with three grooves. A stop is fitted to the quill to knock off the feed automatically at any desired point. It is claimed that the operation of changing the feed is silent and smooth, and is without the shock accom-

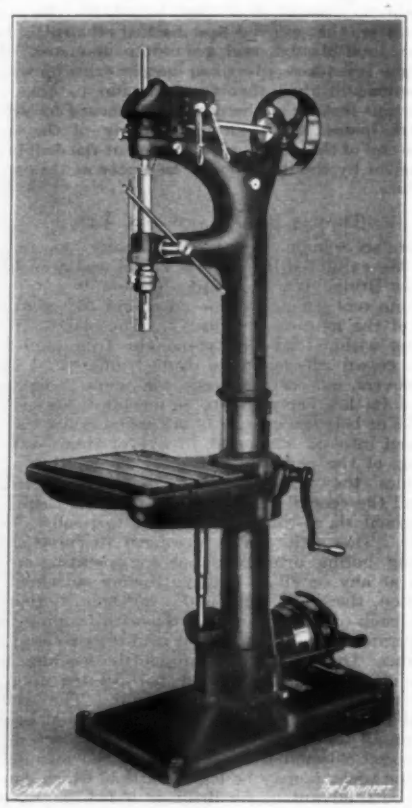


FIG. 43—SENSITIVE DRILLER—JONES AND SHIPMAN

spindle bracket, and is attached to the quill by a clip. The weight of the spindle is taken by a counterbalance suspended by a chain inside the column. The principal feature of the machine is a four-speed gear-box fitted on top of the column. The wheels of this gear-box are of chrome nickel steel, and their engagement is effected by means of hardened steel dog clutches, the whole running in an oil bath. The spindle speeds provided range from 250 to 720 r.p.m.

The 25in. vertical drilling and tapping machine

shown in Fig. 44 is another of Messrs. Jones and Shipman's exhibits. This machine is capable of drilling holes in steel up to 2in. in diameter. Ball bearings are used throughout the design of the machine, and it is claimed that as a consequence the loss of power in the transmission is negligible, the power at the drill point being practically equal to the power of the drive.

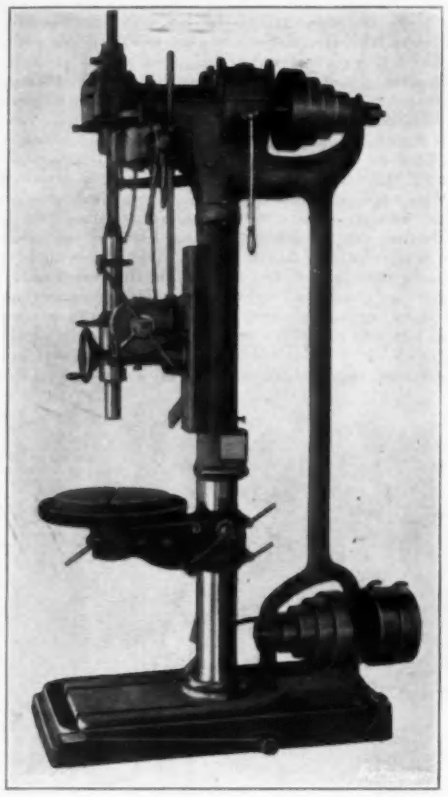


FIG. 44—DRILLER AND TAPPER—JONES & SHIPMAN

The machine is driven through four-stepped pulleys, and back gearing may be brought into the transmission. This back gearing is chain driven, and is totally enclosed in an oil bath. When it is in use the spindle speeds are 16, 25, 40, and 65 r.p.m. When it is cut out the speeds are 100, 160, 250, and 400 r.p.m. The drive to the six-splined spindle is made through spiral bevel gearing. The top shaft is hollow for the purpose of internal lubrication, and is housed in a dust-proof casing. The upper cone pulley is independently mounted on ball bearings in the main frame, with the result that the top shaft is relieved of all the belt loading. An automatic feed box giving four feeds, ranging from 51 to 175 revolutions per inch, is fitted to the side of the head. The feeds are obtained by means of two hand levers operating dog clutches. From the spline shaft descending from this box the feed is transmitted to the quill through a worm wheel and a hardened steel worm running in an oil bath. The engagement of the feed is effected by means of an instantaneous trip mechanism, with which a stop on the quill can be made to operate automatically. The spindle bracket has a vertical adjustment of 18in. and the table a vertical adjustment of 20in.

JOHN HOLROYD AND CO., LTD.

A useful machine worthy of note on the stand of John Holroyd and Co., Ltd., of Milnrow, near Rochdale, is the centring machine shown in Fig. 45. This machine can accommodate work up to 4in. in diameter, and is designed to drill accurately the centres in round,

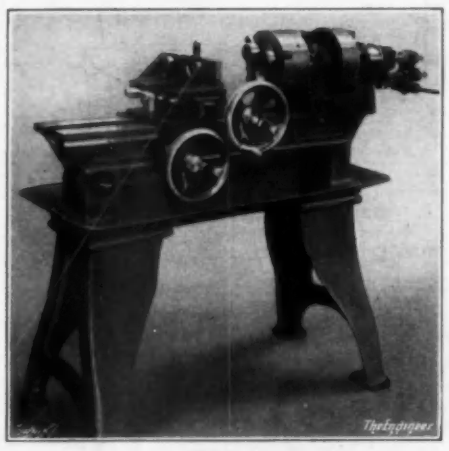


FIG. 45—CENTRING MACHINE—HOLROYD

square or hexagonal stock, and also for centring a variety of forgings and stampings, such as those used in the motor car industry. It is claimed to be particularly useful in the case of parts produced from bar stock in automatic machines. Such parts are in general finished in the automatics without centres. If they have subsequently to be ground the machine illustrated enables the grinding centres to be drilled in them with, it is claimed, great precision. In all cases the work is held in the vee-blocks of the self-centring vice, and does not revolve. It can be moved forward into the centring position by means of a rack and hand wheel. If the work to be centred is of round section the end to be drilled is supported by three rollers mounted on ball journals on a universal chuck. The chuck is driven to revolve with the rollers bearing lightly on the work. If the work is not of circular section, the chuck is held stationary, but the three rollers still fulfil the object of steadying the work. The centring drill is driven independently of the chuck, and is fed into the work by means of a lever at the right-hand end of the machine. The bed of the machine is 3ft. 7in. long, and the centre of the chuck stands 6in. above it.

Another machine on Messrs. Holroyd's stand is the oil stone grinder, illustrated in Fig. 46. This machine is designed for use in woodworking departments, and is useful for sharpening a variety of wood-cutting tools. It is equipped with two spindles driven from a motor in the base. One spindle carries two 8in. oil stones, one of which is of a coarser grain than the other, and both of which run in an oil bath. The other spindle carries at one end an 8in. emery wheel, and at the other a 5in. circular leather strop and a

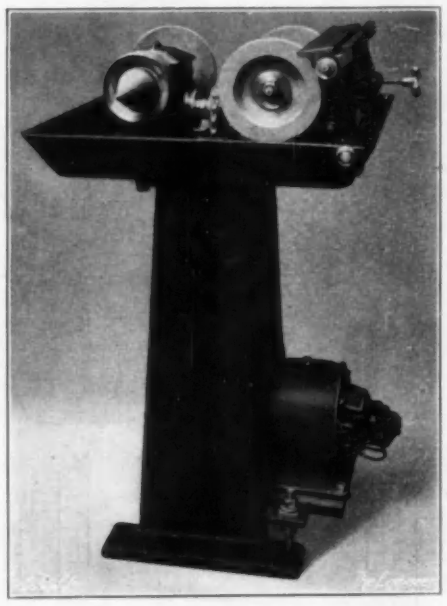


FIG. 46—OIL STONE GRINDER—HOLROYD

grinding cone 3in. in diameter and 5in. long. The spindles run in ball bearings and are driven by totally enclosed worm gearing with oil bath lubrication. A swivelling tool rest is provided in front of the two oil stones and can be swung out of the way when not required. By means of various clamps and fixtures it is possible to sharpen to the correct angle chisels and gouges, trimmer knives, plane irons, planing machine cutters, and so forth. Two or three operators can use the machine simultaneously.

WEBSTER AND BENNETT, LTD.

Boring and turning mills of four or five different types are to be found on the stand of Webster and Bennett, Ltd., of Coventry. One of them, a 48in.

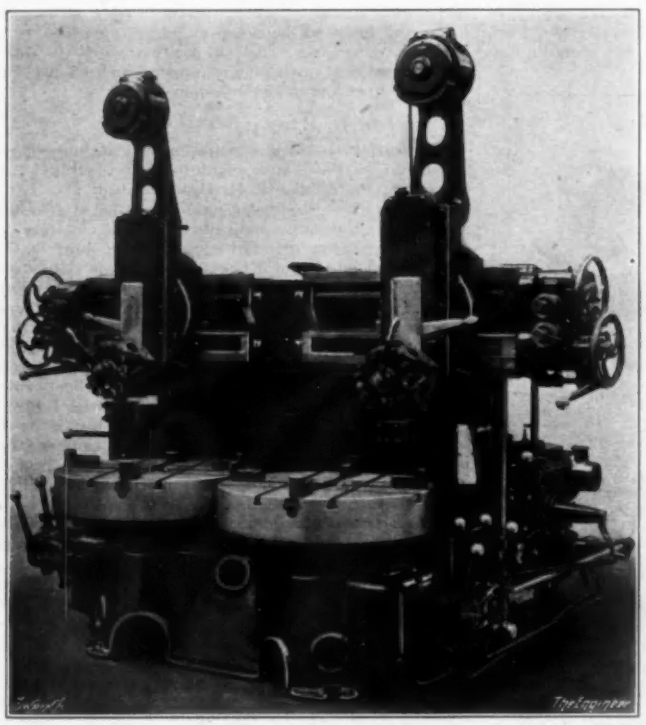


FIG. 47—DUPLEX BORING AND TURNING MILL—WEBSTER AND BENNETT

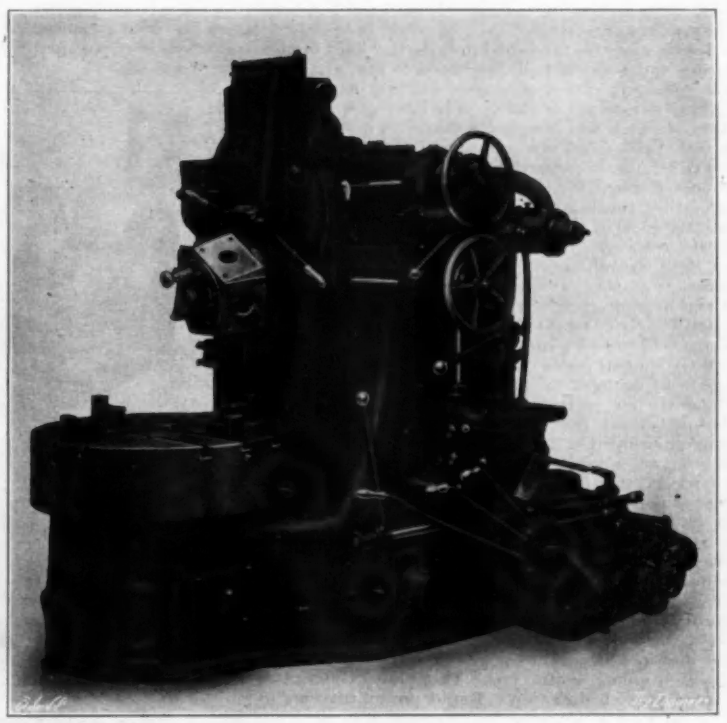


FIG. 48—HIGH-POWER SINGLE MILL—WEBSTER AND BENNETT

single table machine with duplex heads, appears to be identical in design with a machine shown by the firm at the Exhibition of 1924, and described in our issue of September 12th of that year. A second machine on the stands also bears a close resemblance to one exhibited and described four years ago, namely, a 36in. boring and turning mill, or vertical turret lathe, having a single table, a vertical ram carrying a turret for five tools and a horizontal ram carrying a turret

for four tools. Several small changes in the design of this year's machine are to be noted, the principal one being the arrangements made for the support of the side or horizontal ram. In the earlier design the carriage of this ram worked on a pair of vertical guides distinct from the vertical guides on which the cross slide for the vertical ram worked. In the new design the guides for the side ram carriage are formed as a continuation of the right-hand guides for the vertical ram cross slide.

Another of the firm's exhibits is the 36in duplex boring and turning mill illustrated in Fig. 47. This machine may be described as consisting of two side-by-side independent mills, each having a separate table or chuck and a separate ram with a pentagonal turret. Each chuck is equipped with four independent reversible jaws operated by protected screws. The left-hand chuck is fitted with a reversing motion in order that turning and surfacing may be performed with the tools in action on the side of the work nearest to the operator. For boring and reaming the chuck is run in the opposite direction, that is, in the same direction as the right-hand chuck. The chucks are driven by spur gearing in order to eliminate any tendency for them to lift under the drive and are supported on pressure rings of large diameter placed directly beneath them. A range of twelve interlocked speeds in geometrical progression is available independently for each chuck. The speed changes are obtained from gear-boxes, each of which has its controls grouped at the front of the machine. Friction clutches are provided on the first motion shafts, and it is arranged that the gears cannot be changed until the driving pulley has been declutched. The turret rams are balanced by means of springs arranged to give a constant pull throughout the full length of the travel. They have a vertical movement of 22in. and a horizontal movement of 21in. from the centre of the chuck outwards. The rams may be swivelled against a graduated scale for taper boring and turning. The feeds, vertical, horizontal and angular, are reversible and interlocked and are provided with tripping gear of the dropping worm type. There are twelve rates of feed in each direction. Rapid power traverse in all directions is provided by means of a single lever motion which interlocks the power traverses with the feeds. The machine can readily be adapted for an individual motor drive. The motor, when it is required, is mounted on a platform fixed on top of the machine column. An adjusting screw is provided to tilt the platform and the motor, and so to set the driving belt to any desired tension.

Two machines of a design which is being exhibited for the first time are shown on the firm's stand. These machines are a 36in. and a 48in. duplex high-power boring and turning mill. In Fig. 48 we illustrate a 36in. single mill of the same type, and in Fig. 49 give a general arrangement drawing of the 48in. duplex machine actually exhibited. This design of mill has been produced primarily to undertake work on which it is possible to make full use of maximum speeds combined with the coarsest feeds. The factors aimed at in the design are the correct distribution of weight, extreme rigidity, high power and economy of effort on the part of the operator.

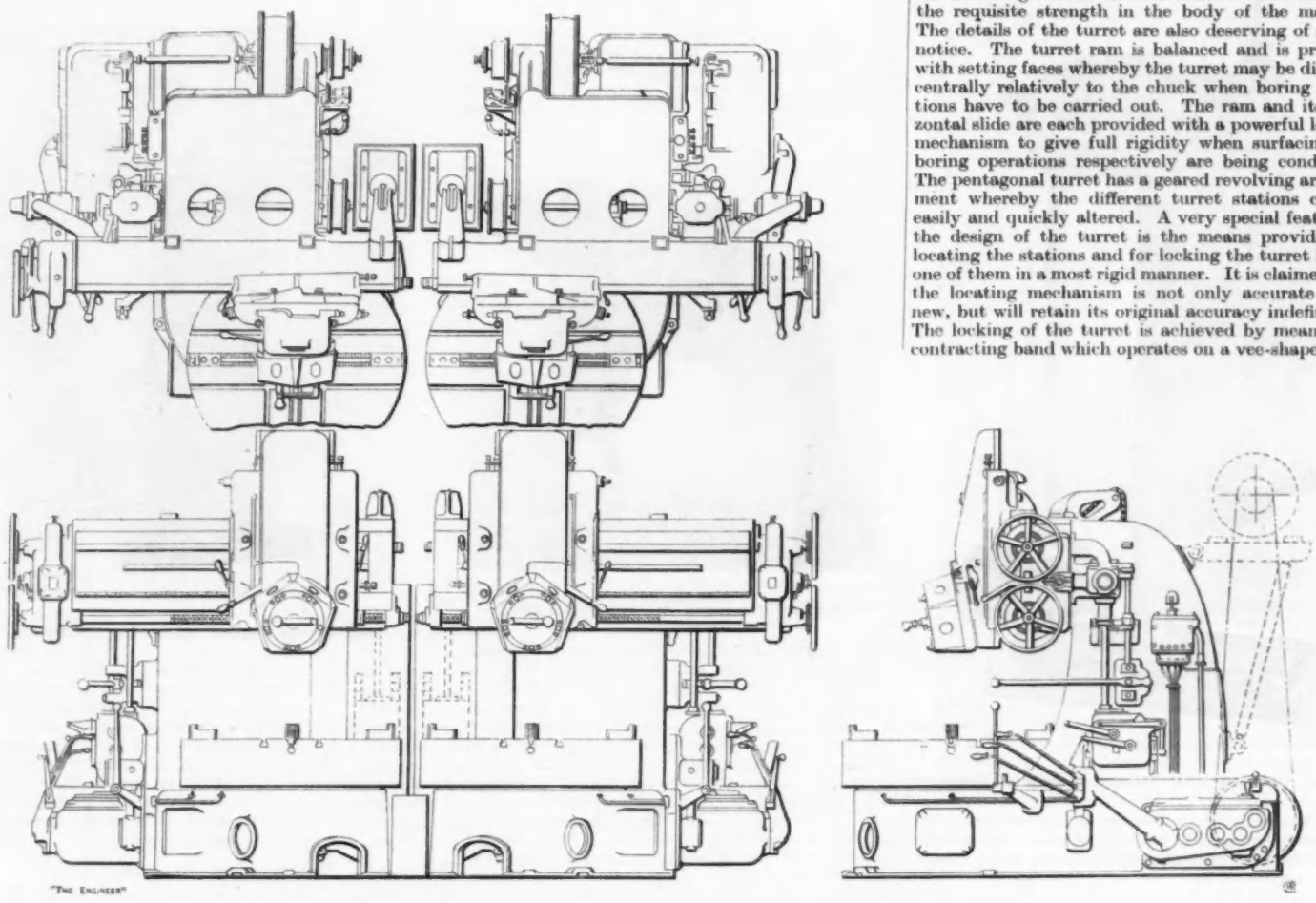


FIG. 49—HIGH-POWER DUPLEX BORING AND TURNING MILL—WEBSTER AND BENNETT

FIG. 50—COMBINED WET AND DRY GRINDER—ROWLAND

In a number of the details the design of these high-power machines follows Messrs. Webster and Bennett's standard practice. The description of the machine shown in Fig. 47 may, in fact, be taken as applying generally to the new design. Attention may, however, be directed to the massive proportions of the chuck and its disposition, in order to secure the greatest amount of rigidity and convenience in operation, at the least height from the floor which is consistent with the requisite strength in the body of the machine. The details of the turret are also deserving of special notice. The turret ram is balanced and is provided with setting faces whereby the turret may be disposed centrally relatively to the chuck when boring operations have to be carried out. The ram and its horizontal slide are each provided with a powerful locking mechanism to give full rigidity when surfacing and boring operations respectively are being conducted. The pentagonal turret has a geared revolving arrangement whereby the different turret stations can be easily and quickly altered. A very special feature in the design of the turret is the means provided for locating the stations and for locking the turret in any one of them in a most rigid manner. It is claimed that the locating mechanism is not only accurate when new, but will retain its original accuracy indefinitely. The locking of the turret is achieved by means of a contracting band which operates on a vee-shaped ring of almost the full turret diameter. It is claimed that these locating and locking features in combination have not hitherto been provided in any design of boring and turning mill. On average work the 36in. machine takes about 10 horse-power per chuck and the 48in. machine about 15 horse-power.

B. R. ROWLAND AND CO., LTD.

In addition to various examples of grinding wheels in silicon carbide and corundum and samples of refractory materials, B. R. Rowland and Co., Ltd., of Reddish, near Stockport, exhibit a range of grinding machines. A notable example is a 24in. electrically-driven double dry grinder, in which the shaft of the centrally situated motor is extended in each direction to carry the grinding wheels at its extremities. This machine is fitted with a self-contained dust exhaust system and with a type of wheel guard which has been evolved to comply with the latest Home Office regulations. The guard has been tested by purposely bursting a wheel at 9400ft. per minute, the normal speed being 5000ft. per minute. The wheel broke into numerous large and small pieces, but none of it escaped from the guard. A description of this machine, together with an illustration of the broken wheel, was given in our issue of June 17th, 1927. Among other grinding machines shown by Messrs. Rowland is the 12in. combined wet and dry grinder illustrated in Fig. 50. The motor of this machine is very completely enclosed to protect it from dust and grit, and was specially produced for the duty by the Metropolitan-Vickers Company. It is provided with a shaft of exceptionally large diameter for its power, and on this shaft the wheels are mounted. The shaft has no bearings other than those in the motor casing. The grinding wheels are spaced sufficiently far apart to enable two operators to work simultaneously at the machine. As in the case of other electrically-driven grinders on Messrs. Rowland's stand, this machine possesses the useful feature of being entirely self contained, which permits it to be placed anywhere desired in the shop and even to be picked up and moved about to fresh positions.